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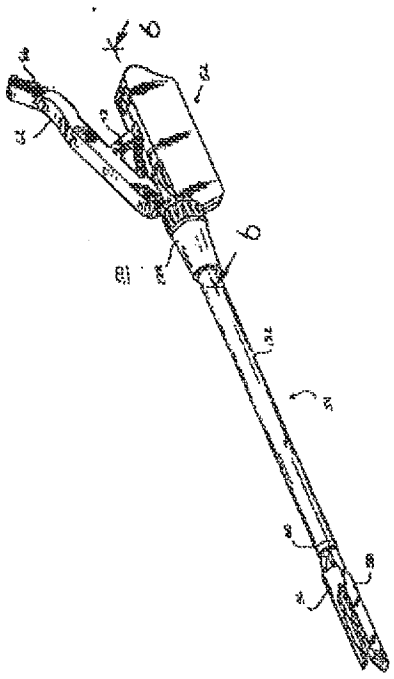
(54)[Title of Invention]: SELF-CONTAINED GAS-POWERED SURGICAL APPARATUS

(57)[Abstract]

[Purpose]: The purpose of the invention is to provide a self-contained gas-powered surgical apparatus for driving a fastener into body tissue.

[Constitution]: A self-contained gas-powered surgical apparatus of the invention is constituted having a frame, an endoscope part, a long housing upon which a cartridge assembly is mounted, an anvil member equipped with a fastener forming surface, a means for moving the anvil member, a shooting means for shooting surgical fasteners, a sealing means to prevent gas from escaping, a self-contained pressurized gas supply source and a pneumatic device equipped with a pneumatic actuator mechanism for the gas supply source, wherein said pneumatic device actuates the surgical fastener shooting means.



[Scope of Claims]

[Claim 1]: A self-contained gas-powered surgical apparatus characterized by

a) having a frame;

b) having an endoscope part that forms a longitudinal axial line and extends forward from the aforementioned frame, wherein said endoscope part,

i) has a long housing equipped with a tip-side member upon whicha a cartridge assembly is mounted, the aforementioned cartridge assembly having a hand-side end and a tip end, plural surgical fasteners being slidably attached to the aforementioned cartridge assembly and the aforementioned cartridge assembly further having a tissue-engaging surface,

ii) has an anvil member equipped with a fastener forming surface, said anvil member being equipped with a tip end and a hand-side end, the aforementioned anvil member being attached to the aforementioned long housing so at least the aforementioned tip end of said anvil member can move between an open position that creates a space from the aforementioned housing and a closed position wherein the aforementioned fastener forming surface proximately and complementarily matches the aforementioned tissue-engaging surface of the aforementioned cartridge assembly,

iii) has a means for moving the aforementioned anvil member between the aforementioned open position and closed position and

iv) a shooting means for shooting the aforementioned surgical fasteners from the aforementioned cartridge assembly, wherein the aforementioned shot fasteners engage with the aforementioned fastener-forming surface and

v) has a sealing means to prevent gas from escaping the aforementioned frame; and

c) further having a pneumatic device that is disposed within the aforementioned frame and is equipped with a self-contained pressurized gas supply source and a pneumatic actuator mechanism pertaining to said gas supply source, wherein said pneumatic mechanism actuates the aforementioned surgical fastener shooting means.

[Claim 2]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned means for moving the aforementioned anvil member between the aforementioned open position and closed position having a tubular collar disposed at least partially around the aforementioned housing and anvil; said tubular collar being equipped with a tip-side cam surface; and the aforementioned tubular collar further having a means that can move between a first position wherein the aforementioned cam surface is disposed on the hand side of the handle-side end of the aforementioned anvil and a second position wherein the aforementioned cam surface is disposed on the tip side of the hand-side end of the aforementioned handle, wherein the aforementioned tubular collar works together with the aforementioned anvil member, presses the aforementioned anvil member to the aforementioned closed position when the tubular collar moves from the aforementioned first position to the second position, and moves the aforementioned collar between the aforementioned first position and second position.

[Claim 3]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by further having a means to rotate the aforementioned endoscope part around the aforementioned longitudinal axial line.

[Claim 4]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned endoscope part being detachably connected to the aforementioned frame, within a self-contained gas-powered surgical apparatus for driving surgical fasteners into body tissue.

[Claim 5]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned anvil member being moved substantially parallel to the tissue-engaging surface of the aforementioned cartridge assembly, between the open position and closed position.

[Claim 6]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned surgical fastener shooting means further being equipped with a pusher element and at least one cam bar actuating the aforementioned pusher element within the aforementioned cartridge assembly, and driving the aforementioned surgical fasteners when the aforementioned cam bar traverses the aforementioned cartridge assembly longitudinally.

[Claim 7]: A self-contained gas-powered surgical apparatus as described in Claim 5 characterized by further having a knife capable of moving in tandem with the aforementioned cam bar.

[Claim 8]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned tip-side member of the aforementioned long housing being equipped with a cartridge assembly detachably mounted to said tip-side member.

[Claim 9]: A self-contained gas-powered surgical apparatus as described in Claim 7 characterized by the aforementioned anvil member being detachably mounted to the aforementioned long housing.

[Claim 10]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned pneumatic device further being equipped with a pressure detection means, being a pressure detection means disposed between the aforementioned gas supply source and pneumatic actuator mechanism, and preventing shooting by the aforementioned surgical apparatus when there is an insufficient amount of pressurized gas for a full shooting cycle.

[Claim 11]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by further having an adjustment means to selectively adjust the longitudinal movement of the aforementioned surgical fastener shooting means.

[Claim 12]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned sealing means being equipped with plural sealing members disposed within the aforementioned endoscope part.

[Claim 13]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by further having a locking means to prevent shooting by the aforementioned surgical apparatus after a prescribed number of shots.

[Claim 14]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by further having a counter means to record the number of times the aforementioned surgical apparatus has been shot.

[Claim 15]: A self-contained gas-powered surgical apparatus as described in Claim 14 characterized by further having a display means to display the shooting status of the aforementioned surgical apparatus.

[Claim 16]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by further having a
[Claim 17]: A self-contained gas-powered surgical apparatus as described in Claim 16 characterized by the aforementioned safety means being equipped with a structure to prevent the movement of the trigger actuating the aforementioned pneumatic device.
[Claim 18]: A self-contained gas-powered surgical apparatus as described in Claim 17 characterized by the aforementioned safety means being equipped with a structure pivotally attached to the aforementioned trigger that can move between a first position to prevent actuation of the aforementioned pneumatic device and a second position at which the aforementioned pneumatic device can actuate.
[Claim 19]: A self-contained gas-powered surgical apparatus as described in Claim 18 characterized by the aforementioned structure being equipped with rotatable wheels that are constantly pressed to the aforementioned first position.
[Claim 20]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by the aforementioned hand-side end of the aforementioned anvil member being capable of more widely opening the anvil member at the open position while being fixed to an angle relative to the longitudinal plane of the anvil member.
[Claim 21]: A self-contained gas-powered surgical apparatus as described in Claim 20 characterized by the aforementioned hand-side end of the aforementioned anvil assuming an angle between 0~30° from the longitudinal plane of the anvil member.
[Claim 22]: A self-contained gas-powered surgical apparatus as described in Claim 1 characterized by further having a clamp lockout means to prevent the adjoining of the aforementioned anvil and cartridge when the aforementioned cartridge or aforementioned anvil is not properly disposed.
[Claim 23]: A self-contained gas-powered surgical apparatus characterized by
a) having a frame equipped with a clamping means;
b) having an endoscope part that forms a longitudinal axial line extending forward from the aforementioned frame, wherein said endoscope part
i) has an extension tube equipped with a tip side wherein a collar tube is attached, said extension tube being rotatably connected to the clamping means of the aforementioned frame so as to be capable of rotating and moving longitudinally through the endoscope part between a first open position and second closed position,
ii) has a cover tube attached to the frame capable of rotatably moving around the longitudinal axial line and
iii) a long support fixed to said cover tube, wherein the aforementioned long support holds the cartridge assembly and is equipped with plural slidably attached surgical fasteners and a tissue-engaging surface, the aforementioned long support further holding an anvil member equipped with a fastener-forming surface, and said anvil member being capable of moving between an open position corresponding to the first position of the aforementioned extension tube and a closed position corresponding to the second position of the extension tube wherein the aforementioned fastener-forming surface proximately and complementarily matches the tissue-engaging surface of the cartridge assembly,
iv) has a shooting means that shoots the aforementioned surgical fasteners from the aforementioned cartridge assembly, wherein the shot fasteners engage with the aforementioned fastener-forming surface, and
v) has a sealing means to prevent the flow of gas to the aforementioned hand-side end from the aforementioned tip side of the aforementioned endoscope part; and
c) having a self-contained pneumatic device mounted within the aforementioned frame, wherein said pneumatic device is equipped with a low-pressure gas supply source and a pneumatic actuator mechanism pertaining to said gas supply source, and said pneumatic actuator mechanism working together with the aforementioned surgical fastener shooting means, shoots the aforementioned surgical fasteners to the aforementioned fastener-forming surface, and the aforementioned pneumatic device further prevents actuation of the aforementioned pneumatic actuator mechanism after a prescribed number of shots of the aforementioned surgical apparatus, within a self-contained gas-powered surgical apparatus for driving surgical fasteners into body tissue.
[Claim 24]: A self-contained gas-powered surgical apparatus as described in Claim 23 characterized by further having an interlock means to prevent actuation of the aforementioned actuator mechanism when the aforementioned clamping means is not at the closed position.
[Claim 25]: A self-contained gas-powered surgical apparatus as described in Claim 24 characterized by the aforementioned interlock mechanism being equipped with a linking mechanism, said linking mechanism being capable of engaging the aforementioned clamping mechanism, and moving between a first lockout position when the aforementioned clamping mechanism is at the open non-clamped position and a second non-engaged shooting position when the aforementioned clamping mechanism is at a closed clamped position.
[Claim 26]: A self-contained gas-powered surgical apparatus as described in Claim 23 characterized by further having a gas sealing means that blocks the aforementioned endoscope part from the aforementioned frame so that it is essentially cut off from the open air.
[Claim 27]: A self-contained gas-powered surgical apparatus as described in Claim 23 characterized by the aforementioned replaceable cartridge assembly having a cartridge housing and cartridge, plural surgical fasteners slidably disposed touching corresponding pushers within said cartridge, the cartridge forming plural longitudinal slots to access the pushers, and further having a cam bar adapter that detachably attaches plural cam bars, the aforementioned cam bars moving longitudinally through the aforementioned longitudinal slots, engaging the aforementioned pushers and shooting staples.
[Claim 28]: A self-contained gas-powered surgical apparatus as described in Claim 27 characterized by the aforementioned plural cam bars being capable of single forward passes through the aforementioned longitudinal slots.
[Claim 29]: A self-contained gas-powered apparatus as described in Claim 28 characterized by the aforementioned cam bars being removed from the aforementioned cam bar adapter after a single forward pass through the longitudinal slots and held within the longitudinal slots, thus disabling actuation of the cartridge assembly.

[Claim 30]: A self-contained gas-powered surgical apparatus as described in Claim 27 characterized by further having a knife attached to the aforementioned cam adapter, and said knife being capable of longitudinal movement through the cartridge.

[Claim 31]: A self-contained gas-powered surgical apparatus as described in Claim 23 characterized by further having a counter means to record the number of times the aforementioned surgical apparatus has been shot.

[Claim 32]: A self-contained gas-powered surgical apparatus as described in Claim 23 characterized by the aforementioned pneumatic device being further equipped with a pressure detection means, said pressure detection means being disposed on a line between the aforementioned gas supply source and the pneumatic actuator mechanism, and preventing shooting of the aforementioned surgical apparatus when there is an insufficient amount of pressurized gas for a full shooting cycle.

[Claim 33]: A self-contained gas-powered surgical apparatus as described in Claim 23 characterized by further having a safety means to prevent unexpected actuation of the aforementioned pneumatic device.

[Claim 34]: A self-contained gas-powered apparatus for endoscopic surgery characterized by

a) having a handle;

b) having a pneumatic device disposed on said handle, wherein said pneumatic device is equipped with a pressurized gas supply source pneumatically connected to a pneumatic actuator means;

c) having an endoscope part that forms a longitudinal axial line and extends forward from the aforementioned frame, wherein said endoscope part

i) has a long housing possessing a tip end equipped with a means to support plural surgical fasteners so these can slide largely horizontally relative to the aforementioned longitudinal axial line, and the aforementioned tip end is equipped with a tissue-engaging surface to support tissue requiring fastening,

ii) has an anvil member equipped with a fastener-forming surface, tip end and hand-side end, and said anvil member is attached to the aforementioned long housing so that at least the aforementioned tip end of said anvil member can move largely horizontally relative to the aforementioned longitudinal axial line between an open position that creates a space from the aforementioned tissue-engaging surface and a closed position wherein the aforementioned fastener-forming surface proximately and complementarily matches the aforementioned tissue-engaging surface,

iii) has a means for moving the aforementioned anvil member between the aforementioned open position and closed position, and

iv) a shooting means for shooting the aforementioned surgical fasteners from the aforementioned fastener support means, wherein the aforementioned shot fasteners engage tissue disposed between the aforementioned tissue-engaging surface and the aforementioned fastener-forming surface; and further has

d) a linking means to connect the aforementioned pneumatic actuator means to the aforementioned surgical fastener means so that it is possible to drive the aforementioned surgical fastener shooting means pneumatically and

e) a safety means to prevent unexpected actuation of the aforementioned pneumatic device, within an self-contained gas-powered apparatus for endoscopic surgery for the purpose of shooting surgical fasteners into body tissues.

[Claim 35]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by the aforementioned pressurized gas supply means being replaceable.

[Claim 36]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by the aforementioned endoscope part being capable of rotation relative to the aforementioned handle.

[Claim 37]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by further having an adjustable shooting means, and said shooting means being associated with the aforementioned pneumatic device for driving the aforementioned surgical fastener shooting means by prescribed longitudinal strokes.

[Claim 38]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by the aforementioned pneumatic device being equipped with a trigger mechanism and capable of being primed so as to move through a complete cycle with a single touch of said trigger mechanism.

[Claim 39]: A self-contained gas-powered surgical apparatus as described in Claim 38 characterized by the aforementioned safety means obstructing the movement of the aforementioned trigger mechanism and preventing the unexpected actuation of the aforementioned pneumatic device.

[Claim 40]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by being equipped with a pressure detection means disposed between the aforementioned gas supply source and a pneumatic actuator means to prevent shooting by the aforementioned surgical apparatus when there is an insufficient amount of pressurized gas for a full shooting cycle.

[Claim 41]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by the aforementioned surgical fastener shooting means further being equipped with a pusher element and at least one cam bar that actuates the aforementioned pusher element within the aforementioned cartridge assembly, and drives the aforementioned surgical fasteners when the aforementioned cam bar crosses the aforementioned cartridge assembly longitudinally.

[Claim 42]: A self-contained gas-powered surgical apparatus as described in Claim 41 characterized by further having a knife that can move together with the aforementioned cam bar.

[Claim 43]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by further having a locking means to prevent shooting by the aforementioned surgical apparatus after a prescribed number of shootings.

[Claim 44]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by further having a counter means to record the number of times the aforementioned surgical apparatus has been shot.

[Claim 45]: A self-contained gas-powered surgical apparatus as described in Claim 43 characterized by further having a display means to display the shooting status of the aforementioned surgical apparatus.

[Claim 46]: A self-contained gas-powered surgical apparatus as described in Claim 34 characterized by further having a clamp lockout means to prevent the aforementioned anvil and

cartridge from approaching when the aforementioned cartridge and aforementioned anvil are not matching

[Claim 47]: A self-contained gas-powered surgical apparatus characterized by

a) having a frame;

b) having an intermediate part forming a longitudinal axial line and extending forward from the aforementioned frame, wherein said intermediate part is equipped with an attachment means to attach a cartridge assembly for which plural surgical fasteners are slidably mounted, the aforementioned cartridge assembly being equipped with a hand-side end, tip end and tissue-engaging surface, and an anvil member being attached to the aforementioned intermediate part, said anvil member being equipped with a hand-side end, tip end and fastener-closing surface, the aforementioned anvil member and cartridge assembly being disposed so that at least the aforementioned tip end of the anvil member can move between an open position for which the aforementioned fastener-closing surface creates a space from the tissue-engaging surface of the aforementioned cartridge assembly and a closed position for which the aforementioned fastener-closing surface proximately and complementarily matches the aforementioned tissue-engaging surface of the aforementioned cartridge assembly, and is equipped with a means to move the aforementioned anvil member between the aforementioned open position and closed position, and a shooting means to shoot the aforementioned surgical fasteners from the aforementioned cartridge assembly, the aforementioned shot fasteners engaging the aforementioned fastener-closing surface, and is further equipped with a pneumatic device disposed within the aforementioned frame equipped with a self-contained pressurized gas supply source and a pneumatic actuator mechanism pertaining to said gas supply source, said pneumatic device actuating the aforementioned surgical fastener shooting means; and further has

c) a safety means to prevent unexpected actuation of the aforementioned pneumatic device and

d) a locking means associated with the aforementioned pneumatic device to prevent shooting of the aforementioned surgical apparatus after a prescribed number of shots, within a self-contained gas-powered surgical apparatus for fixing surgical fasteners within body tissue.

[Claim 48]: A self-contained gas-powered surgical apparatus as described in Claim 47 characterized by the aforementioned surgical fastener shooting means continuously engaging substantially parallel longitudinal rows of the aforementioned surgical fasteners and driving said rows from the aforementioned cartridge assembly, and then engaging them with the fastener-closing surface of the aforementioned anvil member.

[Claim 49]: A self-contained gas-powered surgical apparatus as described in Claim 47 characterized by the aforementioned means for moving the aforementioned anvil member between the aforementioned open position and closed position having a tubular collar disposed at least partially around the aforementioned attachment means and anvil of the aforementioned intermediate part, said tubular collar being equipped with a tip-side cam surface, the aforementioned tubular collar being capable of moving between a first position wherein the aforementioned cam surface is disposed on the hand side of the hand-side end of the aforementioned anvil member, and a second position wherein the aforementioned cam surface is disposed on the tip side of the hand-side end of the aforementioned anvil member, the aforementioned tubular collar works together with the aforementioned anvil member, the tubular collar pressing the aforementioned anvil member to the aforementioned closed position when moving from the aforementioned first position to the second position, and further has a means for moving the aforementioned collar between the aforementioned first position and second position.

[Claim 50]: A self-contained gas-powered surgical apparatus as described in Claim 49 characterized by the aforementioned means for moving the aforementioned collar between the aforementioned first position and second position being equipped with a manual operation handle and a linking assembly connected to the aforementioned tubular collar.

[Claim 51]: A self-contained gas-powered surgical apparatus as described in Claim 47 characterized by the aforementioned anvil member being moved substantially parallel to the tissue-engaging surface of the aforementioned cartridge assembly, between the open position and closed position.

[Claim 52]: A self-contained gas-powered surgical apparatus as described in Claim 47 characterized by the aforementioned surgical fastener shooting means being further equipped with a pusher element and at least one cam bar actuating the aforementioned pusher element within the aforementioned cartridge assembly, and driving the aforementioned surgical fasteners when the aforementioned cam bar crosses the aforementioned cartridge assembly longitudinally.

[Claim 53]: A self-contained gas-powered surgical apparatus as described in Claim 51 characterized by further having a knife capable of moving in tandem with the aforementioned cam bar.

[Claim 54]: A self-contained gas-powered surgical apparatus as described in Claim 47 characterized by the aforementioned cartridge assembly being detachably mounted to the aforementioned long housing.

[Claim 55]: A self-contained gas-powered surgical apparatus as described in Claim 53 characterized by the aforementioned anvil member being detachably mounted to the aforementioned long housing.

[Claim 56]: A self-contained gas-powered surgical apparatus as described in Claim 47 characterized by the aforementioned surgical fasteners consisting of surgical staples, the aforementioned fastener-closing surface of the aforementioned anvil being provided on the anvil, and consisting of plural staple-forming cups for closing the aforementioned surgical staples.

[Claim 57]: A self-contained gas-powered surgical apparatus as described in Claim 56 characterized by the hand-side end of the aforementioned anvil being formed at a fixed angle relative to the longitudinal plane of the aforementioned anvil.

[Claim 58]: A self-contained gas-powered surgical apparatus characterized by

a) having a frame equipped with a clamping means;

b) having a long part that forms a longitudinal axial line and extending forward from the aforementioned frame, wherein said long part.

i) has an extension tube equipped with a tip side for which a collar tube is attached, and said extension tube is rotatably connected to the clamping means of the aforementioned frame so as to be capable of rotating and moving

longitudinally through the long part between a first open position and closed position,
ii) has a cover tube attached to the frame so as to be capable of rotatably moving around the longitudinal axial line,
iii) has a long support fixed to said cover tube, wherein the aforementioned long support holding the cartridge assembly is equipped with plural slidably mounted surgical fasteners and a tissue-engaging surface, the aforementioned long support holds an anvil member equipped with a fastener-forming surface, said anvil member being capable of moving between an open position corresponding to a first position of the aforementioned extension tube, and a closed position corresponding to a second position of the extension tube wherein the aforementioned fastener-forming surface proximately and complementarily matches the tissue-engaging surface of the cartridge assembly,
iv) has a shooting means for shooting the aforementioned surgical fasteners from the aforementioned cartridge assembly, said shooting means being equipped with a channel and a cam bar adapter for attaching at least one cam bar to shoot surgical fasteners, the aforementioned channel being capable of moving longitudinally within the aforementioned long support and rotating in tandem with the endoscope part;
c) having a self-contained pneumatic device attached within the aforementioned frame, wherein said pneumatic device is equipped with a low-pressure gas supply source and a pneumatic actuator mechanism for said gas supply source, said pneumatic actuator mechanism being equipped with a piston connected to the aforementioned channel, a cylinder and a shooting mechanism, and gas from the aforementioned gas supply source being introduced into the aforementioned cylinder when said shooting mechanism is primed and then driving the aforementioned piston and channel longitudinally forward followed by the aforementioned cam bar being moved forward by the aforementioned channel and the aforementioned surgical fasteners being shot;
d) furthermore, having a clamp lockout means connected to the aforementioned clamping means that prevents the anvil and cartridge from approaching when they do not match;
e) and having a locking means connected to the aforementioned pneumatic device to prevent shooting by the aforementioned surgical apparatus after a prescribed number of shots, within a self-contained gas-powered surgical apparatus for driving surgical fasteners into body tissue.
[Claim 59]: A surgical apparatus characterized by
a) having a frame;
b) having a housing equipped with a tip member to attach a cartridge assembly, wherein the aforementioned cartridge assembly is equipped with a tissue-engaging surface and plural surgical fasteners slidably mounted within the cartridge assembly so that they can be continuously shot;
c) having an anvil member equipped with a fastener-forming surface, wherein said anvil member is equipped with a tip end and a hand-side end, the aforementioned anvil member being disposed on the aforementioned housing so that at least the aforementioned tip end of said anvil member can move between an open position, and a closed position wherein the aforementioned fastener-forming surface proximately and complementarily matches the aforementioned tissue-engaging surface of the aforementioned cartridge assembly;
d) having a means connected to the aforementioned housing so as to be capable of moving the aforementioned anvil member between the aforementioned open position and closed position;
e) having a means for shooting the aforementioned surgical fasteners from the aforementioned cartridge assembly, wherein the shot fasteners engage the aforementioned fastener-forming surface;
f) having also a safety means to inactivate actuation of the aforementioned surgical apparatus after the aforementioned surgical apparatus has shot at least a plurality of times, within a surgical apparatus for driving surgical fasteners into body tissue.
[Claim 60]: A surgical apparatus as described in Claim 59 characterized by being equipped also with a pneumatic device disposed on the aforementioned frame, said pneumatic device being equipped with a self-contained pressurized gas supply source and a pneumatic actuator mechanism for said pressurized gas supply source, wherein the aforementioned pneumatic device actuates the aforementioned surgical fastener shooting means.
[Claim 61]: A surgical apparatus as described in Claim 59 characterized by the aforementioned housing forming an endoscope part, wherein said endoscope part forms a longitudinal axial line and extends forward from the aforementioned frame.
[Claim 62]: A self-contained gas-powered surgical apparatus as described in Claim 59 characterized by further having a counter means to record the number of times the aforementioned surgical apparatus has been shot.
[Claim 63]: A self-contained gas-powered surgical apparatus as described in Claim 60 characterized by further having a safety means to prevent unintended actuation of the aforementioned pneumatic device.
[Claim 64]: A surgical apparatus as described in Claim 69 characterized by further having a clamp lockout means to prevent the aforementioned anvil and cartridge from approaching when the aforementioned cartridge or anvil is not correctly disposed within the aforementioned surgical apparatus.
[Detailed Description of the Invention]
[0001]
[Field of the Invention]: The invention pertains to a surgical stapling (staple locking) device, specifically, pertains to a surgical device driven by a relatively low pressure self-contained gas device for performing a consecutive operation of tissue clamping, staple forming and/or tissue cutting, etc.
[0002]
[Prior Art]: Surgical stapling devices of a constitution that first grip, that is clamp, tissue between opposing jaw structures and then fasten then with fasteners are known. Some devices are provided with knives for cutting bonded tissue. In general, fasteners come in the form of surgical staples, but two-part polymeric fasteners are also known.
[0003]: Instruments meant for this purpose may be constituted by two long fingers that are used to grip, that is clamp, tissue. In general, one finger supports a disposable cartridge for holding plural staples disposed in at least two horizontal rows, while the other finger has an anvil, and when the legs of the staples are pressed by the anvil the legs are bent into hooks. Stapling involves the action of a pusher that moves longitudinally along the cartridge holding the fingers

on the staples, and the staple rows being disposed on body tissue. A consecutively actuating knife is properly disposed immediately behind the pusher, wherein said knife is disposed between the staple rows, and longitudinally cuts staple-locked tissue between said staple rows and/or opens said tissue. Surgical instruments of this type are disclosed in US Patent No. 3,079,606 by Bobrov et al and US Patent No. 3,490,675 by Green. The surgical instruments disclosed in these US patents have devices that form vertical incisions and simultaneously attach staple rows to both sides of the incision area.

[0004]: In the art developed since the disclosures in US Patent No. 3,499,591 by Green, double-staple rows are attached to both sides of incision areas. These rows are formed by a cartridge assembly wherein a cam member moves within a guide path between two grooves that support staples alternatingly disposed in a plover shape. Staple members disposed within the grooves have two staple pusher plates and an inclined plane disposed within the guides so that longitudinally moving cams make contact, and are driven along the grooves so that two staples can be shot out.

[0005]: In general, there are various sizes of cartridge assemblies available, with different lengths and numbers of staples contained in each cartridge assembly. Surgeons select suitable cartridges based on the procedure to be performed. At present, it is not possible to obtain a surgical instrument for which it is possible to adjust the shooting means so that various staples may be driven using a single staple cartridge.

[0006]: All of the aforementioned surgical instruments were designed for use during surgery in which a surgeon accesses a surgical site through direct manual procedures. However, in operations in which an endoscope or laparoscope is used, surgery may be performed through a narrow cannula inserted from a small entry or incision made in the skin. Endoscopic surgical stapling apparatus such as that disclosed in US Patent No. 5,040,715 by Green et al were developed based on the special need to perform surgery using endoscopes and/or laparascopes. This apparatus is suited to such operations, and has a tip end equipped with an anvil and staple cartridge assembly, and a manual operation handle assembly wherein an endoscope has been incorporated to enable insertion of the surgical instrument into a cannula and remote operation by a surgeon.

[0007]: All of the aforementioned surgical instruments require some degree of manual effort in order to perform tissue clamping, fastening and/or cutting. This manual effort may be problematic or difficult depending on the direction of the instruments relative to the surgeon, the types of tissue being operated upon or the skill of the surgeon. In addition, cleaning and sterilization of the surgical instruments per each use is difficult and expensive, and the surgical instruments are not made for long-term reuse, leading to concerns over the fact that the instruments are disposed after being used for a single surgical operation. In addition, since self-contained powered surgical instruments are much more convenient, easier to use and produce more consistent results than manual surgical instruments, there is a great deal of interest in self-contained powered surgical instruments. Consequently, there is a need for a self-contained powered endoscopic surgical apparatus without the aforementioned difficulties.

[0008]: Self-contained gas-powered surgical staplers are already known, as disclosed by US Patents No 3,618,842, 3,643,851, 3,662,939, 3,717,294, 3,815,476 and 3,837,555. In general, these staplers have replaceable cylinders to supply gas (carbon dioxide or nitrogen, for example) at relatively high pressures (800 psig, approximately 56 $kg/cm^2g$) to drive the surgical instrument. These staplers use relatively high pressure, and therefore require a relatively heavy construction in order to ensure safety at said pressures. Due to this heavy construction, these surgical instructions are quite expensive, and consequently are generally intended for long-term reuse.

[0009]: The use of relatively low-pressure gas would have the advantage of enabling lightweight construction using less expensive materials. This is desirable from the standpoint of reducing costs and making economical use of disposable staplers. However, staplers must be able to generate the large force required to form a staple. In general, staples are metal wires that are partially formed prior to use, and must be further formed by the stapler (pushing and clamping by the anvil, for example). Normally, a relatively large pneumatic actuator is required to generate the relatively large force required to form a staple with low-pressure gas. This is not desirable, as the stapler becomes bulkier and the work more difficult the larger the actuator. In addition, unnecessarily large actuators expend large quantities of gas between movements not requiring the relatively large force of the actuator (specifically, the first part of an actuator stroke when a staple is simply moving forward to its forming position). When gas is wasted in this manner, the number of staplings that can be performed by the stapler prior to exhaustion of the gas supply source is greatly reduced. Consequently, if the stapler is one for which the gas supply source cannot be replaced, then its effective lifespan is greatly shortened, and if it is one for which the gas supply source can be replaced, then the frequency of gas supply source replacements is inevitably high.

[0010]: Although it is preferable if a self-contained powered element of a surgical apparatus could be automatically used to perform most of the functions of a stapling device, it is also preferable if at least part of an initial function could be manual. For example, in cases in which the initial function is tissue clamping, it would be preferable if the operation could be slowly and accurately started manually, and then before starting part of a series of steps performed by automated self-contained power, inspecting and correcting as needed. Refer to US Patents 4,349,028 and 4,331,277 by Green for examples.

[0011]: Consequently, there is a desire for a self-contained gas-powered surgical instrument for driving surgical fasteners into body tissue that can be manufactured with lightweight materials and can be discarded after use. Endoscopic surgery is generally more common than laparoscopic surgery, so we will explain the invention as it concerns endoscopic surgery and endoscopic devices. However, the terms "endoscope," "endoscopically" and "endoscopic part" used in this application are not intended to limit the invention, which concerns stapling/cutting devices, only to uses related to endoscopic tubes. In addition, the terms "fastener" and "staple" used in this application refer to the same. Unless otherwise specified, the term "cartridge assembly" minimally includes the cartridge itself, staples or fasteners, and staple driving members disposed within cartridge assemblies.

[0012]

[Problems to be Solved by the Invention]: Consequently, the purpose of the invention is to provide a self-contained gas-powered surgical apparatus for driving a fastener into body tissue. Another purpose of the invention is to provide a self-contained gas-powered apparatus that is driven by a low-pressure pneumatic device housed within the apparatus.

[0013]: Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus that can be inserted into a small incision area or narrow tube for driving surgical fasteners into body tissue and cutting tissue between staple rows. Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus that can be discarded after use.

[0014]: Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus that can be selectively set to drive surgical fasteners in various sequences. Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus that can be primed by one push of an actuator so that it moves along the entire operating sequence.

[0015]: Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus equipped with a gas meter ring element to prevent shooting of staples from the cartridge when there is an insufficient amount of gas to move the driving member along the entire operating sequence. Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus equipped with a clamp lockout mechanism to prevent tissue clamping when a cartridge has not been properly inserted within the surgical apparatus.

[0016]: Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus equipped with a sealing structure to prevent the escape of gas from the apparatus. Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus equipped with a counter structure to display the number of apparatus shootings. Another purpose of the invention is to provide a self-contained gas-powered surgical apparatus equipped with a lockout structure to inactivate the actuation of the apparatus after a prescribed number of shootings.

[0017]

[Means to Solve Problems]: The aforementioned and other purposes of the invention, according to the principles of the invention, can be achieved by providing an endoscopic self-contained surgical instrument wherein at least one part is actuated by a relatively low-pressure pneumatic assembly (pneumatic device). A surgical instrument based on a embodiment of the invention is a surgical stapling device that can fix one or more staple rows. A knife is provided by this surgical stapling device to form incisions in body tissue between staple rows. Staples may be given specific forms for use in joining two hollow organs or removing the appendix, gall bladder or other organs.

[0018]: A self-contained gas-powered surgical instrument of the invention in the form of an endoscopic stapler has a frame and an endoscope part that forms a longitudinal axial line and extends forward from the frame. The endoscope part has a long housing equipped with a tip-side end to attach a cartridge assembly. Plural surgical fasteners are slidably attached to the cartridge assembly, and the cartridge assembly further has a tissue-engaging surface. In addition, an anvil member is provided, and said anvil member is equipped with a staple-forming surface and a hand-side end. An anvil member is attached to the long housing so that it can move between an open position and a closed position, and is such that the staple-forming surface proximately and complementarily matches the tissue-engaging surface of the cartridge assembly.

[0019]: A surgical instrument of the invention further has a structure for moving an anvil member between an open position and a closed position, and a structure for shooting surgical staples from the cartridge assembly, engages the staples with the staple-forming surface of the anvil member, and forms the staples on said staple-forming surface. A self-contained pneumatic device is disposed within the frame. Said pneumatic device is equipped with a relatively low-pressure gas supply source connected to a pneumatic actuator mechanism. This pneumatic actuator mechanism primes a structure for shooting surgical staples from the cartridge assembly.

[0020]: A surgical instrument of the invention may be constituted as a reusable unit or as a one-time disposable unit, or may be constituted by a reusable handle part and a replaceable staple support cartridge. Based on the invention, simply by manually clamping the subject tissue and pneumatically actuating the jaw members, it is possible for a surgeon to perform internal surgeries including stapling and/or cutting. Therefore, the use of the surgical instrument is both extremely convenient and easy, and it is possible to more uniformly actuate the mechanism of the surgical instrument.

[0021]: An embodiment of the invention is preferably controlled by a manually-operable trigger or some other similar control mechanism. The actuation cycle of the stapler is started by momentary operation of the trigger, wherein said actuation cycle is normally finished automatically without continuous operation of the trigger. A safety interlock for the trigger mechanism may be used to prevent unexpected actuation. The stapler preferably actuates with a single actuation cycle in response to each control operation unrelated to the length of time. A control device actuates within the time required to start the actuation cycle or more. In addition, the stapler cannot start a new actuation cycle until the previous cycle has finished. In addition, a safety mechanism may be provided to prevent the jaws from closing in the event that the jaws are misaligned or are not properly inserted. In a particularly preferred embodiment of the invention, in cases in which a sufficient quantity of gas does not remain in a reserve chamber for the surgical instrument to achieve a complete cycle, the actuation cycle will not start. The invention may also be separately constituted providing a structure for visual or tactile display of the number of times the surgical instrument has been shot and/or a structure to lock out the actuation cycle after a prescribed number of shootings. A sealing means may also be provided to efficiently seal the surgical apparatus to prevent excess gas from entering the interior of the surgical apparatus.

[0022]: In another particularly preferred embodiment of the invention, the surgical apparatus is provided with an adjustment structure that makes it possible for the surgical apparatus to shoot in a prescribed sequence for driving a prescribed number of staples and/or staple rows. Other characteristics, essentials and various merits of the invention

may be clarified by the attached drawings and detailed description below of the invention.

[0023]

[Embodiment]: Below, we will explain a preferred embodiment of the invention referencing attached drawings. In the attached drawings and description below, "hand side" refers to the end of the side nearest the user, and "tip side (front)" refers to the end of the side farthest from the user. The principles of the invention may be applied to embodiments other than a self-contained gas-powered surgical fastening instrument, an may be fully understood from the description below on applying the principles to an endoscope-using surgical fastening instrument of the form disclosed in US Patent No. 5,040,715 by Green et al. In addition, the principles of the invention may also be applied to a surgical fastening apparatus of another construction, but below we will explain a case in which a staple cartridge housing plural staples, a staple driver (staple driving device) and a staple shooting means that works together with an anvil means are applied to a surgical stapler to individually form opposing jaw structures disposed on the tip end of a stapler to grip and connect body tissue.

I. Overall Structure and Actuation of Shooting Assembly

As shown in Fig. 1, a self-contained gas-powered endoscopic surgical instrument 50 constituted according to the principles of the invention has a frame 52 and an endoscope part 54. An anvil 56 and cartridge assembly 58 are attached to the tip end 60 of the endoscope part 54, and are preferably capable of a wide range of surgical fastening operations via replacement with other anvils/cartridge assemblies (described hereafter).

[0024]: The anvil 56 and cartridge assembly 58 are manually controlled by an adjustment handle 62 of the frame 52. The handle 62 and anvil 56 are mutually connected via the endoscope 54, and when the handle 62 is moved from the open position (Fig. 1) to the closed position (Fig. 8), the handle 56 approaches the cartridge assembly 58. This operation will be explained in detail hereafter.

[0025]: Fig. 2 is an exploded perspective view showing a frame 52 and pneumatic device constituted according to the invention. The frame 52 has a first housing member 64 and a second housing member 66 that encompass a pneumatic device for which the overall structure is indicated by the number 68. The adjustment handle 62 is pivotally attached to the clamping tube 70 at a pivot point 72 of the tip end. A longitudinal groove 74 is formed on the first and second housing members 64, 66 at locations adjacent to the pivot point 72, wherein said groove 74 slidably receives a molded shaft mounted to the handle 62 at the pivot point 72. The molded shaft 76 is pivotally mounted to the tip end of the handle 62 on both sides of the pivot point 72, and has a function to guide the tip end of the handle 62 towards the tip-side direction when the handle 62 has been compressed.

[0026]: The middle part of the handle 62 is connected to a pair of projecting parts 80 formed on the respective surfaces of the housing members 64, 66 by a pair of joint links 78. A handle return spring 82 is disposed between the handle 62 and housing members 64, 66 via spring-loaded pins 84. One spring-loaded pin 84 is disposed on the handle 62, while another spring-loaded pin 84 is disposed between the pair of projecting parts 80, wherein the latter spring-loaded pin 84 has a function to pivotally attach the joint link 78 to the projecting part 80. A spring 82 helps to return the handle 62 to the open position from the closed position.

[0027]: The hand-side end of the handle 62 is diagonally formed in a direction away from both housing members 64, 66, preferably so that a surgeon can more easily release the handle 62 from its closed position by hand. This is achieved by placing a hand below the hand-side end of the handle 62 and then lifting the handle 62. A roughly sectioned part 86 is provided on the underside of the hand-side end of the handle 62, preferably one that increases the gripping effect of the handle 62.

[0028]: The entire structure of the pneumatic device 68 is housed within the two housing members 64, 66, with a container 88 of gas of relatively low pressure slidably mounted longitudinally within said pneumatic device. The gas pressure within the container 88 when the stapler is actuated is usually approximately 200 psig (approximately 14 $kg/cm^2g$), preferably approximately 80~160 psig (approximately 6~12 $kg/cm^2g$). The gas may be a halogenated hydrocarbon that remains in a gaseous state while at room temperature, including fluorinated hydrocarbons such as freon-12 or chlorinated hydrocarbons such as Freon-152A. However, it is not restricted to this, and may be any suitable non-toxic gas. When the shooting trigger 96 is pressed, the container 88 distributes the relatively low-pressure gas through a stem 90, valve 92 and gas tube 94. A spring 97 is disposed between the container 88 and valve 92, wherein said spring 97 has a function to separate the container 88 from the valve 92. The valve 92 is fixed within the housing members 64, 66, and can be adjusted longitudinally by a lock spring 93 (Fig. 14). This characteristic makes it possible to change the disposition of the valve 92 longitudinally, and consequently, it is possible to compensate for differences in length due to the manufacturer of the container 88 between the tip end and hand-side end of the stem 90.

[0029]: A pneumatic actuator 98 is disposed above the container 88 between the housing members 64, 66. The actuator 98 has a pneumatic cylinder 100. Said cylinder 100 is held to a fixed position by opposing pins 99, and except for a ferrule 102, the hand-side end thereof being closed and the tip end being open. A pneumatic piston 104 is mounted within the cylinder 100 so that it is capable of parallel reciprocal movement relative to the longitudinal axial line of the endoscope part 54. The cylinder 100 preferably has a circular cross-section, but other shapes may also be capable of demonstrating acceptable functions.

[0030]: The piston 104 is pneumatically sealed to the cylinder 100 by an O-ring 106 formed of polyethylene or similar material. The gas distributed from the container 88 is supplied to the pneumatic actuator 98 via the gas tube 94. The gas tube 94 introduces gas into the cylinder 100 through a ferrule 102 on the back of the piston 104, and drives the piston 104 in a tip-side direction (forward) within the cylinder 100. The tip end of the piston 104 is such that it engages with the shooting mechanism of the surgical apparatus as described hereafter.

[0031]: As shown in Fig. 2, Fig. 5 and Fig. 8, the shooting trigger 96 is pivotally mounted to the tip-side ends of the housing members 64, 66 by a pivot pin 108. A spring 110 is disposed adjacent to the pin 108, and said spring 108 has a function to press the shooting trigger 96 towards the hand

side to press it into the pre-shooting position. A trigger rod 112 longitudinally extends in the tip-side direction from the shooting trigger 96, wherein said trigger road 112 engages with the piston slide 114 disposed on the bottom of the piston 104. The piston slide 114 substantially consists of a U-shaped channel, and fits into a corresponding groove 116 formed on the piston 104. The piston slide 114 is primed in the hand-side direction by the spring 118, and a horizontal projecting part 120 that engages the tip end of the trigger rod 112 is provided on the tip end below.

[0032]: Referring to Fig. 2 and Fig. 6~Fig. 12 (initially Fig. 2, Fig. 6~Fig. 9 and Fig. 12), a swinging lever 120 is pivotally attached to a horizontal slide pin 122, wherein said swinging lever 120 is such that it can move horizontally relative to the slide pin 122 between a pre-shooting engaged position (Fig. 8~Fig. 10) and a non-engaged position when the joint handle 62 is open (Fig. 6, Fig. 7). A cam slider 124 is vertically attached within the first housing member 64 so that it can reciprocally move between an up position (Fig. 7) and a down position (Fig. 9), and has a function to move the swinging lever 120 between the engaged position (Fig. 9) and the non-engaged position (Fig. 7). Consequently, the surgical instrument 50 cannot be shot until the joint handle 62 is closed, and the swinging lever 120 has been moved to the engaged position by the cam slider 124.

[0033]: The cam slide 124 is always primed in the up non-engaged position (Fig. 6, Fig. 7) by a cam slide spring 126 attached within the vertical groove 128 in the first housing member 64. In this up position, the cam slide 124 projects upwards from the first housing member 64, and engages with the joint handle 62 when said joint handle 62 has moved to the closed position (Fig. 8, Fig. 9). The cam slide 124 further has a cam surface 130, wherein said cam surface 130 touches a cam surface corresponding to a cam block 132 attached to the slide pin 122. The cam block 132 is primed against the cam slide 124 by the slide spring 134, and moves the swinging lever 120 horizontally between the engaged position and non-engaged position. As shown in Fig. 9, when the joint handle 62 is pressed in the direction of the arrow 135 towards the housing members 64, 66, the joint handle 62 touches the cam slide 124, and moves said cam slide 124 down. Therefore, the cam surface 130 moves the cam block 132 and swinging lever 120 horizontally towards the engaged position matching the piston 104.

[0034]: As shown in Fig. 6, Fig. 8~Fig. 10 and Fig. 12, if the joint handle 62 is fully pressed once, then the swinging lever 120 will be disposed so that it matches the piston slide 114, pivots around the horizontal slide pin 122 and engages the pusher disk 136 at the tip end of the container 88. If the shooting trigger 96 is pressed when the surgical instrument 50 is clamped, then the trigger rod 112 will be moved longitudinally in the tip-side direction, and the piston slide 114 will engage with the swinging lever 120 and pivot. Thus, the swinging lever 120 engages the pusher disk 136 and longitudinally moves the container 88 to touch the valve 92, distributes the gas and propels the piston 104 in the tip-side direction (see Fig. 12~Fig. 14).

[0035]: When the piston 104 moves in the tip-side direction, the swinging lever 120 is maintained in the shooting position by touching the base surface of the piston 104. A gap 138 is formed on the base surface close to the hand-side end of the piston 104. Said gap 138 releases the engagement of the swinging lever 120 and the piston 104, and is pivoted so that the container 88 returns to a position free from engagement with the valve 92, and thereby the flow of gas to within the pneumatic cylinder 100 is stopped.

[0036]: Return springs 140, 142 disposed within the endoscope part 54 drive the piston 104 and return it to its initial pre-shooting position. A cam surface 144 is formed on the tip end of the gap 138, wherein said cam surface 144 moves the swinging lever 120 horizontally, then moves horizontally and is released from engagement with the piston 104 when the cam surface 144 returns to the hand side and the swinging lever 120 moves to its original pre-shooting position (Fig. 8).

[0037]: Fig. 15 shows another embodiment of the invention. This embodiment incorporates an adjustment mechanism 146 to selectively enable adjustment of a surgical instrument 148, so that it changes the shooting length and piston 150 return stroke. This superior characteristic enables users to use a single surgical instrument to selectively shoot staples of prescribed length. For example, if a user installs a staple cartridge assembly equipped with six rows of staples (wherein the longitudinal length of each row is 60 mm), the surgical instrument 148 can be set so that it can shoot staples of the entire length of the cartridge by using the adjustment mechanism 146. Therefore, it is also possible shoot staples after inserting a somewhat shorter cartridge, based on the user's needs.

[0038]: The adjustment mechanism 146 shown in Fig. 15 has a belt 152 that runs around a pair of longitudinally disposed pulleys 154, 156. A first linking road 158 is engaged with the top part of the belt 152 and extends to a gap adjustment member 160 slidably disposed within the piston 150. A second linking rod 162 is engaged with the bottom part of the belt 152 and extends to a slidable piston stopper 164 disposed within the pneumatic cylinder 100.

[0039]: The belt 152 can be rotated in any direction, whether clockwise or counterclockwise, by rotating a knob 166 disposed within the housing 172 between the pulleys 154, 156. This enables users to pre-select the shooting stroke of the surgical instrument 148. For example, if the belt 152 is rotated counterclockwise, the shooting stroke piston stopper is driven to the hand side by the second linking rod 162, and the gap 168 by which the swinging lever 120 releases engagement with the pneumatic actuator 98 is correspondingly widened. Thus, a user can shoot small rows of staples without replacing the cartridge assembly. Conversely, if the belt 152 is rotated clockwise, then the shooting stroke is gradually lengthened, and as a result, makes it possible for the user to shoot the entire length of the staple rows within the cartridge assembly.

[0040]: With the surgical instrument 148 shown in Fig. 15, it is possible to preset the shooting stroke so that any 30 mm row or 60 mm row staples can be shot from a cartridge assembly 60 mm in length. These preset positions correspond to cam pins 186, 170, wherein said pins 186, 170 each release the engagement of the first rod link 158 from the belt 152, and are such that the belt 152 does not rotate during the shooting stroke of the pneumatic actuator 98.

[0041]: Fig. 16 shows another superior characteristic incorporated into a pneumatic device of the invention. This characteristic is the detection and/or adjustment of the gas distributed to the cylinder 100 from the container 88 by.

placing a pressure sensor 174 on the line between the valve 92 and pneumatic cylinder 100. It is important to include devices for driving surgical fasteners (more specifically, devices for cutting fastened tissue using a knife) during surgical operations so that a sufficient amount of gas remains within the container 88 to complete a full piston firing stroke when the trigger is pushed. If there is insufficient gas, then the piston may not be able to generate the force to fasten tissue and/or cut the desired length of tissue, thus making surgery difficult. The pressure sensor 174 has a function to measure beforehand the amount of gas necessary to achieve a desired piston stroke, before gas has entered the pneumatic cylinder 100 so as to be able to drive the piston 104.

[0042]: A counter mechanism that actuates in relation to the pneumatic actuating device may conceivably be incorporated to monitor the number of shots fired by the surgical instrument 68. If the number of shots can be visually displayed for the user, than it would be possible to overhaul or replace the surgical instrument after a prescribed number of shots, for example. Similarly, in the event that only a relatively small number of shots is possible with a single gas container, than this counter mechanism would assist in informing the user that they the container is close to becoming empty. A particularly preferred embodiment can also combine a counter mechanism and a lockout mechanism to disable actuation of the shooting mechanism after a prescribed number of shots.

[0043]: As shown in Fig. 16, if the shooting trigger 96 is pressed, then gas is substantially released from the container 88 as described above. However, the gas makes contact with a pressure plate 176 through a nozzle 92 after a stem 90 comes out. The pressure plate 176 is preset by a spring 178 so that it maintains an orifice 180 in a closed state until a prescribed gas pressure is achieved on said pressure plate 176. Once threshold force is achieved, the pressure plate 176 moves and no longer touches the orifice 180, and as a result, the gas enters the pneumatic cylinder 100 through the orifice 180 and drives the piston 104 in a tip-side direction. If there is insufficient gas to achieve this threshold force, then the pressure plate 176 will continue to block the orifice 180, making it impossible to shoot the surgical instrument.

[0044]: Fig. 3 shows the exploded detailed structure of the endoscope part 54 of an embodiment of the invention. On the hand-side end, a piston 104 is capable of longitudinal reciprocal movement through the clamping tube 70, and extends into the hand-side end of a cover tube 182. An attachment flange 184 is provided on the tip end of the piston 104, wherein plural pusher washers 186 are attached to said flange 184. These pusher washers 186 are substantially formed into truncated circular cones from an elastic material such as commercial spring steel or 302 stainless steel. These washers 186 are commonly known as Belleville Spring Washers (conical spring washers), sold by SPEC Associated Spring Raymond, Barnes Group Inc. These washers are suitable for receiving high loads within a small space, and can achieve a variety of load-bearing capacities by being combined as a changeable continuous body. In the embodiment in Fig. 3, as shown in Fig. 4, two washers are disposed in six opposing pairs, and essentially 12 pusher washers 186 are used in total. Spring support washers 188 are disposed on the tip side of the pusher washers 186, wherein said spring support washers 188 have a function to engage with the hand-side end of inside return sprints 140 and outside return springs 142. These washers are held at a prescribed position on the flange 184 by lock washers 189. Attachment washers 184 have chamfered tip ends and a form and dimensions that can be received between a hand-side finger 190 and channel 192.

[0045]: As shown in Fig. 3 and Fig. 17~Fig. 19, the channel 192 is a long structure that can be slidably attached within the endoscope part 54 so as to be capable of reciprocal motion longitudinally within the endoscope part 54. As described above, a finger 190 that can receive the attachment flange 184 of the piston 104 is provided on the hand-side end of the channel 192. A fork 194 is provided on the tip end of the channel 192, and a slot 196 is formed between these. The hook 194 has a pair of mutually opposing ramp surfaces 198, 200, wherein the purpose of these lamp surfaces 198, 200 will be explained in detail hereafter. The hand side of the hook 194 touches a structure 202, wherein said structure 202 is disposed below a fork 194 of minimum dimensions.

[0046]: Looking at Fig. 3 again, an extension sleeve 204 is disposed within the cover tube 182, and the hand-side end of said extension sleeve 204 is fixed to a clamping tube 70. A sealing member 206 is attached to the flange 208 of the clamping tube 70, wherein said sealing member 206 has a function to seal the frame 52 of the surgical instrument 50 from the endoscope part 54. The inside and outside return springs 142, 140 are each housed in a top extension spacer 210 and a bottom extension spacer 212, wherein both spacers 210, 212 are fixed within the extension sleeve 204. The spring support washer 188 touches the hand-side end of the inside and outside return springs 142, 140, and if the surgical instrument is shot, transmits the energy of the compression springs 142, 140, and returns said piston 104 to its pre-shooting position.

[0047]: A support structure 214 is also disposed within the extension spacers 210, 212, wherein said support structure 214 has a function to releaseably receive an anvil and/or cartridge assembly of the surgical instrument 50. The support structure 214 is held at a prescribed position within the extension spacers 210, 212 by a horizontal support key 216. An anvil return spring 218 is attached to the bottom part of the support structure 214, wherein said anvil return spring assists in holding the anvil within the surgical instrument.

[0048]: A collar assembly, whose overall structure is indicated by the number 220, is mounted to each of the tip ends of the external sleeve 204 and the extension spacers 210, 212. This collar assembly 220 has a front collar tube 222, a collar tube spacer 224 and a back collar tube 226, with cam bosses 268, 270 formed on each of their respective inner surfaces as described in detail below.

[0049]: In the embodiment of the invention shown in Fig. 1~Fig. 3, the endoscope part 54 can be rotated relative to the frame 52 by a rotating knob 228 (Fig. 1, Fig. 2). This rotating knob 228 has a truncated circular cone structure, with a penetrating bore that maintains the dimensions to receive the hand-side end of the cover tube 182. A knurl is provided on the hand-side end of the knob 228, and may be easily rotatable. Once connected to the cover tube 182, it is possible to rotate the other working end of the surgical instrument 50 by rotating the knob 228.

[0050]: Referring to Fig. 5, an anvil 230 and cartridge assembly (overall structure indicated by the number 232)

based on a embodiment of the invention are shown. The anvil 230 is a long member attached to the support 214 by the hand-side leg 250. An anvil plate 236 is provided on the tip end of the anvil 230, wherein said anvil plate 236 has a tissue contact surface 238 equipped with a staple-forming concavity 240 (see Fig. 20). A top cam surface 242 and locking surface 244 are provided on the hand-side end of the anvil 230, wherein these surfaces 242, 244 engage the corresponding arc-shaped cam surface 246 formed on the front collar tube 222. An opposing projecting part 248 is formed on the leg 250 of the hand-side end of the anvil 230, wherein said projecting part 248 forms an engagement point of the anvil 230 to receive cam action between an open position and closed position by the interaction of the cam surface 242, locking surface 244 and the top arc-shaped cam surface 246 of the collar tube 222. The radius of curvature of the top arc-shaped cam surface 246 is preferably shorter than the radius of curvature of the cam surface 242 and equal to the radius of curvature of the locking surface 244. In this manner, it can prevent the bending of the cam surface 246 of the collar tube 222 and sideways movement of the anvil when the anvil receives cam action and is closed.

[0051]: The anvil plate 230 also has a longitudinal middle groove 252 that enables passage of a knife 254. Furthermore, mutually parallel matching surfaces 256 disposed below the cam surface 242 are provided on the anvil 230. These matching surfaces 256 have the dimensions to mate with the outside projecting part 258 of the cartridge housing 260 when they close the anvil 230. The engagement of the matching surfaces 256 and the projecting part 258 corresponding to the cartridge housing 260 makes it possible to accurately match and fix the anvil 230 and cartridge housing 260 when closed. A pair of longitudinal concavities 262 formed on the tip end of the anvil 230 make it possible to make a separate visual confirmation of matching. These concavities 262 are such that it is possible for a surgeon to visually check the closed structure of the anvil 230 and cartridge assembly 232, confirm that these are accurately matched longitudinally.

[0052]: Furthermore, as shown in Fig. 22, the horizontal plane formed by the tissue contact surface 238 intersects the horizontal plane formed by the cam part of the hand-side end of the anvil 230 at an obtuse angle "$\alpha$." This angular constitution results in a pre-camber being conferred upon the anvil 230, achieving a balance with the closing force applied to the tissue gripped by the anvil 230. A first cam surface 264 and second cam surface 266 are each formed on the side wall part of the hand-side end of the anvil 230. These cam surfaces 264, 266 engage each of the cam bosses 268, 270 formed on the inside opposing side walls of the collar tube assembly 220. The anvil 230 is inserted into the collar tube assembly 220. In addition, the projecting part 248 engages with the support structure 214, and matches the cam surfaces 264, 266 with the cam bosses 268, 270, making it possible for them to engage. The cartridge assembly 232 (said assembly is described hereafter) is inserted into and fixed within the collar tube assembly 220, and then maintained in a stationary position relative to the anvil 230.

[0053]: When manufacturing the anvil 230, the anvil material may be formed by metal extrusion casting, followed by coining and coating described later. A wide range of staples and fasteners may conceivably be used with the surgical fastening apparatus in the invention. In a preferred embodiment used for titanium fasteners, it has been determined that forming the fasteners inside of a staple-forming concavity 240 may be accomplished by providing a hard and relatively smooth surface on the staple-forming part of the anvil 230. A preferred method of forming this surface is to form the surface by chemical plating (electrodeless plating) using allows of nickel, gold, silver, titanium nitride or chrome, for example. If nickel is used, the preferred thickness of the surface formed is 100~2,000 μ, while an optimum thickness would be 200~500 μ. The range of thickness for other alloys may be changed based on their individual peculiar properties.

[0054]: A nickel surface is preferably formed by a chemical plating method consisting of the following processes, specifically, a process to electrolytically clean the anvil with a cyanide-containing cleaner, a process to reverse polarity with a current of approximately 50 amperes/ft$^2$ and within a prescribed time interval (preferably every 10~15 seconds approximately), a process for complete rinsing, a process for repeated dipping and rinsing in a solution containing a strong acid (preferably 20% hydrochloric acid), a process for soaking in a NiCl strike tank for plating, preferably for two~four minutes, and a process for soaking the anvil at approximately 50 amperes/ft$^2$, preferably for 2~4 minutes, in an electrodeless Ni bath (preferably Enthone 418 or 431) for a sufficient time to achieve a desired plating thickness. For example, a time of 30~40 minutes may be required to achieve a thickness of approximately 300 ± 50 μ at a plating speed of 0.0005 in/hr. Other coating methods such as deposition may be considered; such methods also being covered by the invention.

[0055]: Fig. 5 and Fig. 23~28 show a replaceable cartridge assembly 232 based on the invention. This cartridge assembly 232 has a cartridge housing 260, a cartridge 272 wherein plural matching pushers 274 and staples 276 disposed longitudinally are housed, plural cam bars 278 detachably disposed within a cam bar adapter 280, and a cam bar matching tab 282 and knife 254 mounted to the cam bar adapter 280.

[0056]: Particularly as shown in Fig. 26~Fig. 28, the hand-side end of the cartridge housing 260 is substantially formed by a long chamber with a semicircular cross section equipped with a front part 284 and a back part 286. A horizontal lock slot 288 is formed on the back part 286, wherein said lock slot 288 has a function to engage with the support structure 214 to hold it. If the support structure 214 is inserted into the collar tube assembly, then the front end of the support structure 214 is pressed by the back part 286 of the cartridge housing 260 until said support structure 214 engages with the lock slot 288.

[0057]: A backward projecting part 290 is formed on the base part of the cartridge housing 260. The function of this projecting part 290 is described hereafter. A bore 292 is provided on the front part of the projecting part 290 that will receive a shear pin 294 formed on the cam bar adapter 280 (Fig. 23~Fig. 25). A pair of crimps 296 are provided on the opposing side walls of the back part of the hand-side end of the cartridge housing. These crimps 296 form a frictional fit with the cam bar adapter 280.

[0058]: The front part 284 of the hand-side end of the cartridge housing 260 has a projecting part 258, wherein said projecting part 258 touches the anvil matching surface 256

and matches said surface 256 as described before, when it has closed the cartridge assembly 232 and anvil 230. The tip end of the cartridge housing 260 is constituted by a channel structure with a substantially rectangular cross section. This tip end constitutes a cartridge receiving part and has dimensions that can receive a cartridge 272. A bore 298 and projecting part 300 respectively engage the pin and bore of the cartridge 272, and match and hold the cartridge 272 within a cartridge receiving part of the cartridge housing 260.

[0059]: As shown in Fig. 27, the cartridge receiving part of the tip end of the cartridge housing 260 and the hand-side end of the cartridge housing 260 are connected at an obtuse angle θ formed by the intersection of the horizontal plane of the hand-side end of the cartridge housing 260 and the horizontal plane of the tip end. This angular constitution results in a pre-camber being conferred upon the cartridge assembly, making it easy to properly close and match the jaw element, and more properly hold target tissue.

[0060]: The cartridge 272 has a longitudinal groove structure 302 for receiving and guiding a knife 254, and plural pushers 274 that touch the staples 276. The staples 276 are disposed in three rows on both sides of the groove structure 302, and may be disposed longitudinally in six rows. Two pairs of longitudinal slots are formed on the cartridge housing 260, wherein these slots may receive a pair of double cam bars 278. Each pair of cam bars has a function to drive three longitudinal corresponding rows of staples. In addition, two pairs of longitudinal slots extend to the end of the cartridge 232.

[0061]: A cam surface 304 is provided on the top tip end of the cam bar 278, and a projecting shelf part (overhang shelf part) 306 equipped with a vertical surface 308 is provided on the bottom tip end. This projecting shelf part 306 has the dimensions to extend into the longitudinal slot up to the point that the vertical surface 308 of the projecting shelf part 306 drops and touches the front edge part 310 of the cartridge holding part of the cartridge housing 260 when the cam bars 278 have moved to their front shooting position. A hook structure 312 has been provided on the cam bars 278 on the hand-side end, and these are such that they can releasably engage with the cam bar adapter 280.

[0062]: Fig. 23~Fig. 25 are drawings showing a cam bar adapter 280 based on an embodiment of the invention. The cam adapter 280 has a front section 314 and a back section 316. The front section 314 has an substantially rectangular shape, and when a cam bar adapter 280 is pressed to the furthest position on the front section 314, a middle longitudinal groove 318 is formed that possesses the dimensions to receive the longitudinal groove structure 302. A flange 320 and shelf part 322 have a function to detachably hold the hand-side end of the cam bar 278.

[0063]: The back section 316 has a rectangular shape, with a projecting part 324 formed on the hand-side end. The back section 316 has the dimensions to be received within the slot formed in the hook 194 of the channel 192. The projecting part 324 has the dimensions to engage with the ramp surface 198, and when the hook 194 is moved in the tip direction, said hook 194 is such that it can catch on the projecting part 324.

[0064]: A vertical bore 326 and longitudinal groove 328 are formed on the back section 316, and these have a function to hold the knife 254. A shear pin 294 is integrally formed into the bottom surface of the cam bar adapter 280, wherein said shear pin 294 matches the bore 292 at the pre-shooting position and is received within said bore 292. In addition, at this pre-shooting position, the back section 316 of the cam bar adapter 280 is disposed on the back projecting part 290, and effectively shield engages the touching structure 202 and projecting part 290.

[0065]: Fig. 29~Fig. 35 show a second preferred embodiment of an anvil/cartridge assembly based on the invention. As shown in Fig. 29 and Fig. 30, a cartridge assembly 330 has a cartridge housing 332, and a cartridge 334 is attached to the tip end of said cartridge housing 332 to house plural pushers 336 disposed under the staples 338. A pair of cam bars 340 are disposed on the cartridge housing 332, wherein said cam bars 340 are such that they can move longitudinally through mutually parallel longitudinal slots formed on the cartridge 334. A cam surface 342 is formed on the top tip end of the car bars 340, and a projecting shelf part 344 is formed on the bottom tip end. A vertical shelf part 346 is formed on the hand side of the projecting shelf part 344, wherein said vertical shelf part 346 is such that it can engage with the tip end of the cartridge housing 332 when the cam bars 340 have been driven to these complete tip positions. A cam bar matching tab 348 engages both cam bars 340, and holds these at parallel matching positions. The cam bar adapter 350 is such that it can receive and fix the shank part of the cam bars 340.

[0066]: The cartridge 334 has three longitudinal rows of staples and as shown in Fig. 29 the each staple row are designed offset from its adjacent staple row. This embodiment of the invention does not use a knife and is designed to attach staple rows to body tissue. As shown in Fig. 31 and Fig. 32, the anvil 352 has essentially the same design as the anvil 230 previously described for the previous embodiment, The key difference is unlike anvil 230, which is constituted to house six rows of staples and possesses a knife, anvil 352 is such that the tip end 354 is narrow, and receives and forms three longitudinal staple rows. Anvil 352 extends longitudinally and has a mutually parallel pair of legs 356, wherein said legs 356 are equipped with horizontal opposing projecting parts 358. Mutually parallel matching surfaces 360 are formed on the side walls of the anvil 352, wherein said matching surfaces 360 have a function to overfit and match the anvil 352 on the cartridge housing 332. A first and second cam surface 362, 362 are formed on the side walls of the anvil 352 close to the mutually parallel matching surfaces 360, and these cam surfaces 362, 364 have a function to engage respective cam bosses 268, 270 formed on the front collar tube 222 and back collar tube 224.

[0067]: A top cam surface 366 is formed on the top surface of the anvil 352 close to the tip end 354, and a locking surface 368 is formed on the tip end adjacent to the top cam surface 366. Both the top cam surface 366 and the locking surface 368 are such that they engage the top are-shaped cam surface 246 formed on the tip end of the front collar tube 222 and perform cam action.

[0068]: Fig. 36~Fig. 40 show a further separate embodiment of the invention similar to the embodiment in Fig. 1~Fig. 16 equipped with the jaw structure in Fig. 29~Fig. 35. As shown in Fig. 36 and Fig. 37, the handle part of this embodiment further has toroidal seals 101, 103 provided between the tip end of the frame 52 and the hand-side end of

the collar tube 182. These seals prevent escaping of the insufflation gas from the surgical site. Respective seals 107, 109 are disposed adjacent to the hand-side end and tip end of the clamp tube 70, wherein these seals 107, 109 provide a good block between the insufflation gas and the piston 104 region.

[0069]: A counter mechanism is also disposed on the handle part 52, wherein said handle mechanism has a counter ratchet 400 attached to the trigger rod 112, and a flat spring 402 attached to the housing 66 so as to be capable of engaging with the teeth on the bottom surface of said counter ratchet 400. A counter display device is longitudinally disposed on the outer surface of the counter ratchet 400, wherein the numbers displayed by said counter display device are the same as the number of shots fired by the surgical instrument. An access plate 404 equipped with a narrow window 406 is disposed on the outer surface of the housing 66.

[0070]: During actuation, each time the surgical instrument is shot, the flat spring 402 engages respective teeth disposed on the hand side of the counter ratchet 400, effectively slides the counter ratchet 400 to the tip side, and conforms to the next small number of the observation window 406. The counter mechanism of this embodiment further has a locking characteristic wherein a trigger button 96 is held at the shooting position when the flat spring 402 engages the furthest hand-side surface of the counter ratchet 400, thus preventing the shooting rod 112 from returning to its hand-side non-shooting position.

[0071]: This embodiment of the invention further has an integrated trigger button rotary safety mechanism consisting of a rotary safety shaft 408 disposed within a roller 410. The rotary safety mechanism is rotatably disposed within the trigger button 96, and is equipped with a roller 410 that extends past the back surface plane of the trigger button 96. A projecting part 412 is eccentrically formed on both sides of the rotary safety shaft 408, and extends over the plane of the side surface of the trigger button 96. A spring 414 acts to always press the rotary safety mechanism, and dispose the projecting part 412 at the furthest position on the tip side.

[0072]: As shown in Fig. 39 and Fig. 40, at the non-shooting position of the surgical instrument (Fig. 39), the projecting parts 412 are at their furthest position on the tip side, and are disposed so that they directly match the hand-side ends of the housing members 64, 66. At this position, the trigger button 96 cannot be unexpectedly pressed down to shoot the surgical instrument. To release the safety mechanism, the roller 410 is moved in the direction of the arrow 416. Thus, the projecting parts 412 are rotated from their furthest tip-side positions (Fig. 39) to their furthest hand-side positions (Fig. 40), and consequently, the trigger button 96 can be pressed down to shoot the surgical instrument. When the roller 410 is released, the safety mechanism is returned to its normal position by the spring 414, and can subsequently prevent unexpected shootings.

[0073]: Fig. 38 shows the endoscope part and jaw part of the surgical apparatus in Fig. 36. A pair of angled hand-side legs 420 is provided on the anvil 418 of this embodiment. This characteristic enables wide opening of the anvil 418, consequently making it possible to easily receive tissue between the anvil 418 and cartridge 58. These angled hand-side legs 420 are preferably disposed at an angle within a 0~30° range from the longitudinal plane of the anvil 418.

[0074]: Fig. 38, Fig. 41 and Fig. 42 show the details of a clamp lockout structure incorporated into the support structure 214 and top extension spacer 210. The clamp lockout structure has a spring 430, wherein a projecting part 432 that extends diagonally downwards is attached to said flat spring 430. A slot 434 is formed on the top surface of the support structure 214, wherein said slot 434 is such that when the support structure does not longitudinally match, then it will always engage the projecting part 432 and receive it. This clamp lockout mechanism is designed and constituted so that there will be no closing of tissue by the jaw if the cartridge and/or jaw element is not properly installed in the surgical apparatus.

[0075]: During actuation of the stapling device in Fig. 38, the flat spring 430 and projecting part 432 are always disposed on the support structure 214. The hand-side ends of the cartridge 334 and anvil 418 are inserted into the collar tube 222 and engage the tip end of the support structure 214 (see Fig. 41). If the cartridge 334 and/or anvil 418 are properly and/or completely inserted and engaged within the support structure 214, then the slot 434 will match the projecting part 432 as a result of the angle disposition of the support structure 214 thus produced (see Fig. 42). When the user attempts to push down the handle 62, the extension spacer 210 will start to move to the tip side, placing the projecting part 432 in the slot 434, and then being caught within said slot 434. Thus, further movement of the extension spacer 210 to the tip side is completely prevented, consequently preventing the anvil 418 and cartridge 334 from approaching.

II. Operation of Surgical Instrument

During use, the endoscope part of the surgical instrument is inserted into a body (preferably inserted via an endoscope tube). In addition, it is preferred that the endoscope tube device can maintain a sealed pneumoperitoneum, so that even if a surgical instrument of the invention is inserted into the endoscope tube, the internal sealing member of the housing can still maintain this seal. Actually, the jaws of the surgical instrument can be inserted into an endoscope tube while closed through cam movement of the jaw by picking the anvil and cartridge or closing the joint handle before insertion.

[0076]: After insertion into the endoscope tube, it is possible to rotate the endoscope part, and to properly position the surgical instrument at the stapling site. Rotation of the endoscope relative to the body may be achieved by rotating the entire surgical instrument, or by rotating the endoscope part relative to the frame by using a rotating knob 228 (see Fig. 1), or a combined operation of the two.

[0077]: As shown in Fig. 3, Fig. 6~Fig. 9 and Fig. 33~Fig. 35, if the surgical instrument is properly positioned so that the tissue to be fastened is disposed between the open jaws of the surgical instrument (specifically, between the tissue contact surface of the anvil member 230 and the tissue contact surface of the cartridge 302), then tissue is clamped by the closing of both jaws. In the first embodiment, when the surgeon pressed down the actuating handle 62, the collar tube assembly 220 slid to the tip side, and furthermore the extension sleeve 204 and extension spacers 210, 212 slid to the tip side via the clamp tube 70.

[0078]: As shown in Fig. 33~Fig. 35, when the collar tube assembly 220 moves from a first position wherein the top arc-shaped cam surface of the tip end of the front collar tube 222 is disposed close to the cam surface 242, to the tip side

along the arrow A, to reach a second position wherein the top arc-shaped cam surface 246 engages with the locking surface 244 (Fig. 35), the top arc-shaped cam surface 246 touches the cam surface of the anvil, and as a result, the anvil is pressed to the cam via the cam surfaces 264, 266 of the cam bosses 268, 270, until the anvil closely complementarily matches the cartridge assembly. Fig. 35 shows the jaws of the surgical instrument in a closed position.

[0079]: After the jaws of the surgical instrument have been closed, the instrument is ready for shooting. If a surgeon inserts staples and is prepared to cut tissue, as described before, they actuate the pneumatic actuator 98 by pressing down the shooting trigger 96. Thus, the piston 104 attached to the hand-side end of the channel 192 is driven to the tip side, the cam surface of the hook 194 catches the projecting part 324 of the cam bar adapter 280, and drives the cam bar adapter in the direction of the tip side. Thus, after the shear pin 294 is cut, and the cam bar and knife have been driven longitudinally through the cartridge, the staples are driven and formed, and tissue is cut.

[0080]: When the piston 104 touches the return springs 140, 142, and moves forwards towards the cartridge assembly, the pusher washers 186 are mutually compressed, and energy is stored. This initial compression is within 20~150 psig approximately (approximately 1.4~11 kg/cm$^2$g), preferably 30~60 psig approximately (approximately 2.1~4.2 kg/cm$^2$g). Close to the end of the forward stroke of the piston 104, this stored energy is released, driving the cam bar 278 through the final movement limit to the front of the cam bar 278 within the longitudinal slot of the cartridge. At the front limit of this longitudinal stroke, the projecting shelf part 306 of the cam bar 278 drops to the top of the edge part of the cartridge housing, and thus the vertical surface 308 and edge part 310 touch.

[0081]: After staple shooting, the flat springs 140, 142 engage the piston 104, and return said piston 104 to its original position. The return movement of the piston 104 results in cam movement to the side due to the cam surface 144 of the piston 104. In an embodiment equipped with the knife 254 described beforehand, the cam bar 278 is withdrawn from the cam bar adapter 280, and then is left at a prescribed position within the longitudinal slot of the cartridge 334. A cam bar adapter 280 to which a knife 254 has been mounted moves to the hand side within the cartridge housing 272 until the outer edge part of said cam bar adapter 280 collides with the crimps 296.

[0082]: The cam bar adapter 280 is held at a prescribed position by the crimps 296, and the cam surface 200 of the hooks 194 in between catch the hooks 194 on the projecting parts 324 of the cam bar adapter 280, and engage said projecting parts 324. The channel 192 continues to move in the direction of the hand side until the touching structure 202 is disposed close to the back projecting parts 290 formed on the floor of the cartridge housing 260. At this point, priming of the entire cartridge assembly 232 is prevented.

[0083]: In the event that a surgeon unintentionally attempts to again shoot the surgical instrument without replacing a cartridge for which priming has been prevented with a new unused cartridge, an abutting structure 202 will move and abut the back projecting parts 290 due to longitudinal movement towards the front of the resulting channel 192, and the further movement of the hooks 194 towards the cam adapter 280 will be effectively prevented.

[0084]: After shooting, the joint handle 62 is lifted up with assistance from the handle return spring 82, the action of which causes the collar tube assembly 220 to be withdrawn. This withdrawal movement causes the anvil 230 to be released from engagement with the cartridge assembly 232. Similarly, the lifting up of the joint handle 62 causes the cam slider 124 to be moved up, and the pneumatic shooting mechanism to be released.

[0085]: The surgical instrument is withdrawn from a patient to replace the cartridge assembly. If the cartridge assembly is released, then it can be removed by pulling said cartridge assembly forward from the collar tube assembly 222. To insert a new cartridge assembly, insert the hand-side end of a cartridge assembly into the collar tube assembly 222 until the cartridge assembly engages the support structure 214 and is locked to it. Thus, the surgical instrument is ready for re-insertion and continued use.

[0086]: The operation of a surgical instrument equipped with the cartridge and anvil assembly shown in Fig. 29~Fig. 32 is substantially similar to that described above. Tubular tissue requiring ligature and/or division is gripped during the operation so that said tissue is horizontally disposed between the anvil 352 and cartridge assembly 330. The cartridge assembly 330 and anvil 352 approach as a result of the cam surfaces 362, 364 and cam bosses 268, 270 as described above, staples 338 are shot, and tissue is ligatured.

[0087]: Unlike in the previous embodiment, the cartridge assembly 330 is not equipped with a knife, and thus does not require the cam bar to be withdrawn by the channel 192. During actuation, the tip end of the channel 192 engages the hand-side end of the cam bar adapter 350, and drives the cam bar 340 to their furthest forward position (Fig. 35). At this position, the projecting shelf part 344 drops to the top of the tip end of the cartridge housing 332, and remains here. When the piston 104 is withdrawn, the channel 192 moves in a direction away from the cam bar adapter 350, and withdraws to a position close to the back projecting part 290. Thus, the cam bar 340 and a cam bar retainer 350 remain at a front position within the cartridge assembly 332. The opening, removal and replacement of a cartridge released from priming are substantially the same method as described before for the second embodiment.

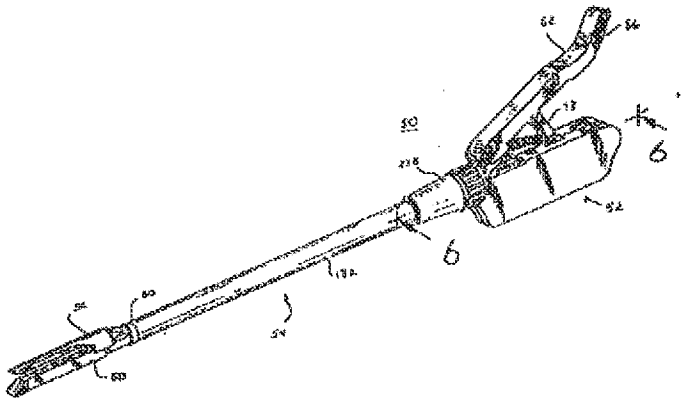
[0088]: It should be understood that various modifications may be made to the various embodiments of the invention described above, as long as they do not deviated from the principle or scope of the invention. For example, the surgical instrument may be of various sizes, and may be manufactured using various constituent materials. In addition, the components may be modified into various shapes. For example, in the first embodiment, a long slot that can be accessed by a thumb ring may be provided to any of the left or right side unit parts. Consequently, the above descriptions in this applications do not limit the invention, and may simply be thought of as examples of preferred embodiments. Persons skilled in the art may consider other modifications as long as they are within the scope and principles of the invention described in the scope of claims.

[Brief Description of Drawings]

[Fig. 1]: Perspective view showing a self-contained gas-powered endoscopic surgical instrument based on an embodiment of the invention.
[Fig. 2]: An exploded perspective view showing the frame and pneumatic assembly (pneumatic device) of the surgical device in Fig. 1.
[Fig. 3]: An exploded perspective view showing the endoscope part of the surgical instrument in Fig. 1.
[Fig. 4]: A side view showing a partial cutaway of a push washer and flange member of a pneumatic device of an embodiment of the invention.
[Fig. 5]: An exploded perspective view showing an embodiment of an anvil and cartridge assembly of the surgical instrument in Fig. 1.
[Fig. 6]: A side section along line 6-6 in Fig. 1 showing a frame and pneumatic assembly in the unclamped/non-shooting position.
[Fig. 7]: A cross section facing the hand-side end of a surgical instrument cut along the line 7-7 in Fig. 6 showing a frame and pneumatic assembly in the unclamped position.
[Fig. 8]: A side section showing a frame and pneumatic assembly in clamped/non-shooting position.
[Fig. 9]: A cross section facing the hand-side end of a surgical instrument cut along the line 9-9 in Fig. 8 showing a frame and pneumatic assembly in the clamped/non-shooting position.
[Fig. 10]: A planar view facing the tip end of a surgical instrument cutting along line 10-10 in Fig. 6 showing the frame and pneumatic assembly of a surgical instrument.
[Fig. 11]: A planar view facing the tip end of a surgical instrument cutting along line 11-11 in Fig. 6 showing the frame and pneumatic assembly of a surgical instrument.
[Fig. 12]: A side section showing a frame and pneumatic assembly in clamped/fixed position.
[Fig. 13]: A partial side section showing the actuation of a pneumatic assembly of the invention during firing.
[Fig. 14]: A partial side section along the line 14-14 in Fig. 13 showing the valve and gas tube of the pneumatic assembly.
[Fig. 15]: A side section showing the frame and pneumatic assembly of a surgical instrument that incorporates an adjustable troke mechanism.
[Fig. 16]: A partial side section of a surgical instrument that incorporates a metering assembly between the valve and piston assembly.
[Fig. 17]: A side view showing a channel member based on an embodiment of the invention.
[Fig. 18]: A cross section facing the hand-side end of a channel member cut along the line 18-18 in Fig. 17.
[Fig. 19]: A cross section facing the tip end of a channel member cut along the line 19-19 in Fig. 17.
[Fig. 20]: A bottom view showing an anvil member based on an embodiment of the invention.
[Fig. 21]: A plane view showing the anvil member in Fig. 20.
[Fig. 22]: A side view showing the anvil member in Fig. 20.
[Fig. 23]: A plane view showing a cam bar adapter of an embodiment of the invention.
[Fig. 24]: A side view showing the cam bar adapter in Fig. 23.
[Fig. 25]: A plane view facing the hand-side end of the cam bar adapter cut along the line 25-25 in Fig. 23.
[Fig. 26]: A side section showing the cartridge housing in Fig. 5.
[Fig. 27]: A plane view showing the cartridge housing in Fig. 26.
[Fig. 28]: A side section cut along the line 28-28 in Fig. 27 of the cartridge housing in Fig. 26.
[Fig. 29]: An exploded perspective view showing another embodiment of the cartridge assembly of a surgical instrument of the invention.
[Fig. 30]: A perspective view showing the cartridge assembly in Fig. 29 in an assembled state.
[Fig. 31]: A perspective view cutting part of an anvil and cartridge assembly of the invention.
[Fig. 32]: A perspective view cutting part of an anvil of the embodiment in Fig. 31.
[Fig. 33]: A partially cut side view showing the series of actuations of the anvil and cartridge assembly in Fig. 31.
[Fig. 34]: A partially cut side view showing the series of actuations of the anvil and cartridge assembly in Fig. 31.
[Fig. 35]: A partially cut side view showing the series of actuations of the anvil and cartridge assembly in Fig. 31.
[Fig. 36]: A perspective view showing another self-contained gas-powered surgical instrument of the invention.
[Fig. 37]: An exploded perspective view showing the handle part of the self-contained gas-powered surgical instrument in Fig. 36.
[Fig. 38]: An exploded perspective view showing the endoscope part and jaw structure of the self-contained gas-powered surgical instrument in Fig. 36.
[Fig. 39]: A side section showing a shooting trigger equipped with an integrated lockout in a non-shooting position.
[Fig. 40]: A side section showing a shooting trigger equipped with an integrated lockout in a shooting position.
[Fig. 41]: A side view of a cartridge and support structure, showing the actuation of the clamp lockout mechanism.
[Fig. 42]: A side view of a cartridge and support structure, showing the actuation of the clamp lockout mechanism.
[Explanation of References]:
50 self-contained gas-powered endoscopic surgical instrument
52 frame
54 endoscope part
56 anvil
58 cartridge assembly
62 joint handle
64 first housing member
66 second housing member
68 pneumatic actuating device
70 clamping tube
76 shuttle
78 joint link
88 container
92 valve
96 shooting trigger
98 pneumatic actuator
100 pneumatic cylinder
104 piston
136 pusher disk
192 channel
194 fork
196 slot
204 extension sleeve
214 supporting structure
220 collar assembly

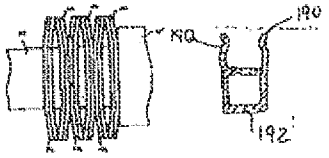
230 anvil
232 cartridge assembly
260 cartridge housing
272 cartridge
274 pusher
276 staple
280 cam bar adapter
302 groove structure
306 projecting shelf
330 cartridge assembly
332 cartridge housing
334 cartridge
336 pusher
338 staple
340 cam bar
350 cam bar adapter
352 anvil
400 counter ratchet
418 anvil
430 flat spring

[Fig. 1]



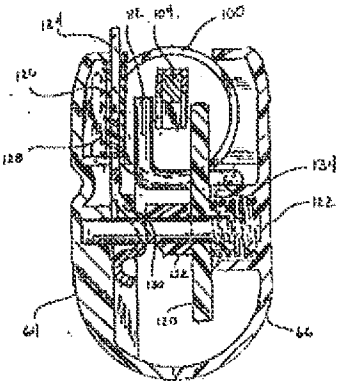
[Fig. 2]

[Fig. 4]

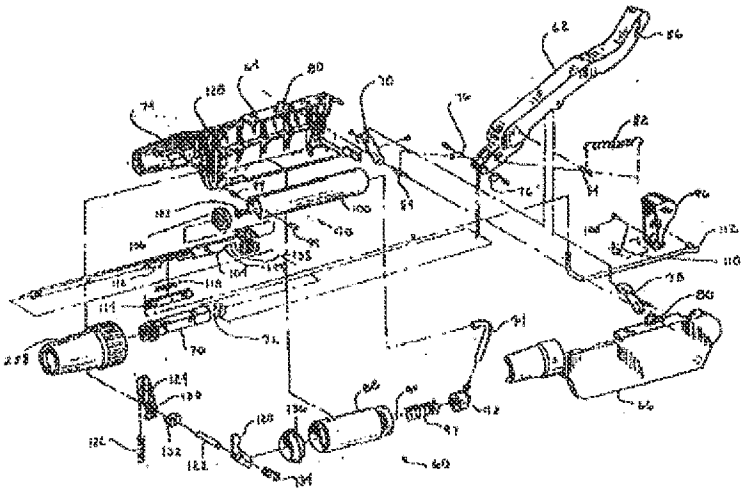


[Fig. 7]

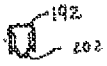
[Fig. 18]

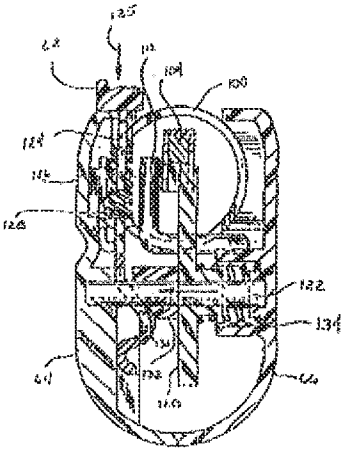


[Fig. 9]

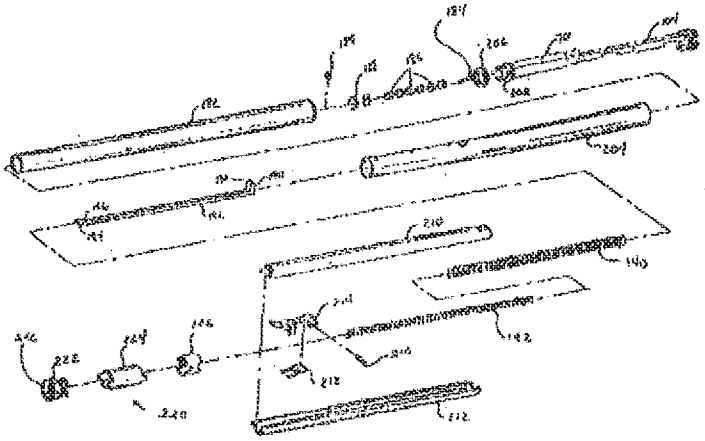


[Fig. 19]

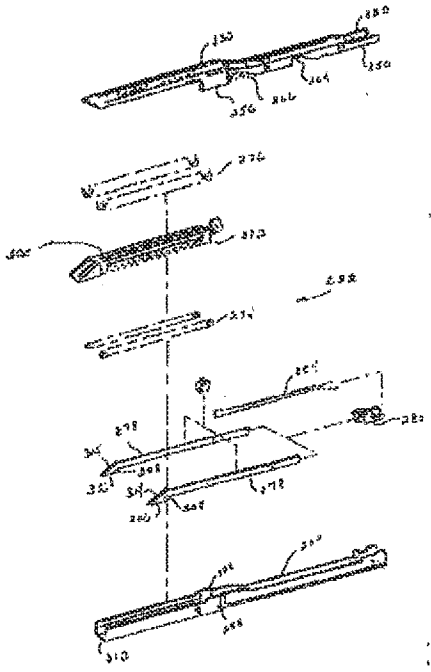




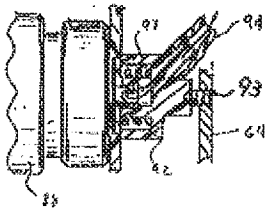
【図３】
[Fig. 3]



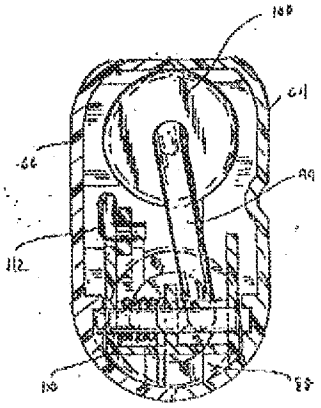
【図５】
[Fig. 5]



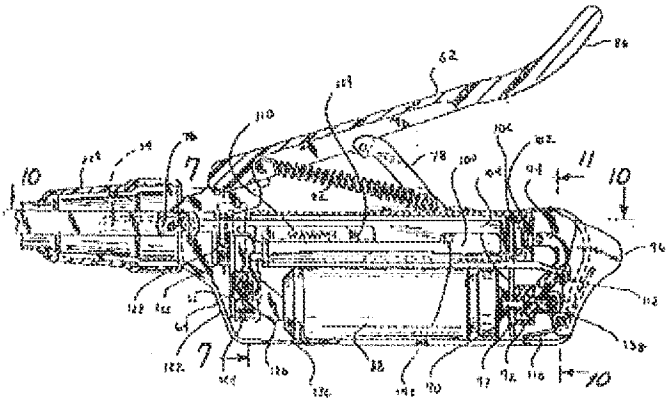
【図１４】
[Fig. 14]



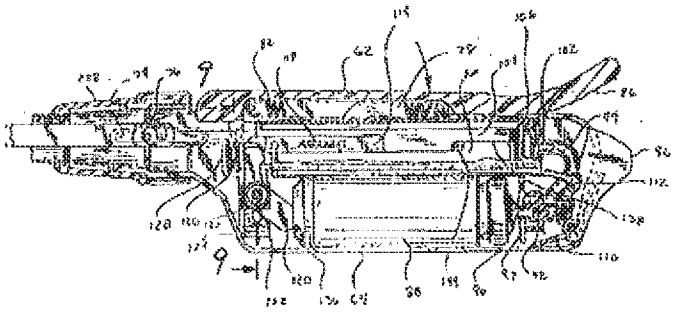
【図１１】
[Fig. 11]



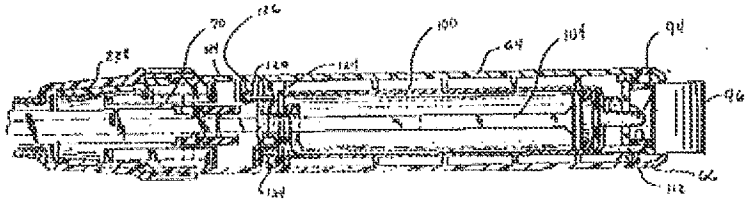
【図６】
[Fig. 6]



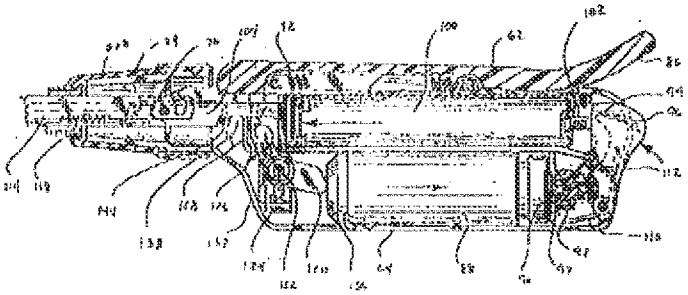
【図８】
[Fig. 8]



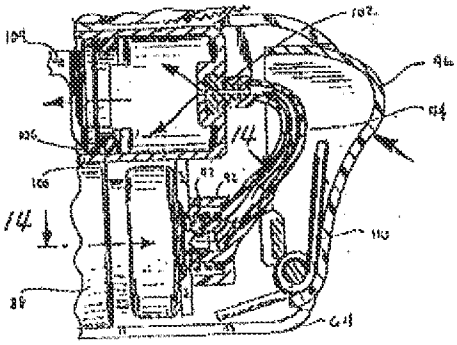
[Fig. 10]



[Fig. 12]

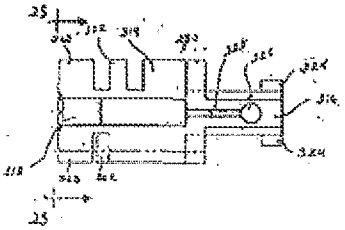


[Fig. 13]

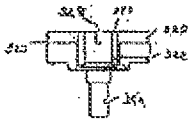


[Fig. 15]

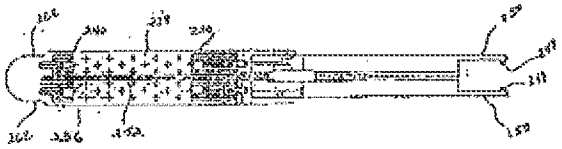
[Fig. 23]



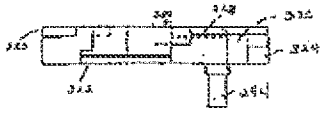
[Fig. 25]



[Fig. 20]



[Fig. 24]



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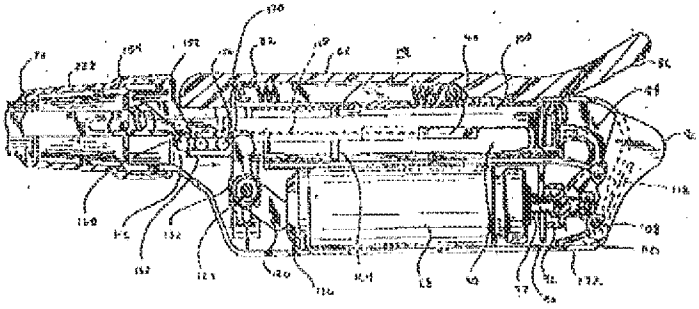
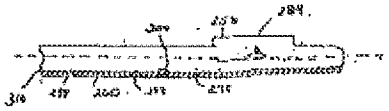
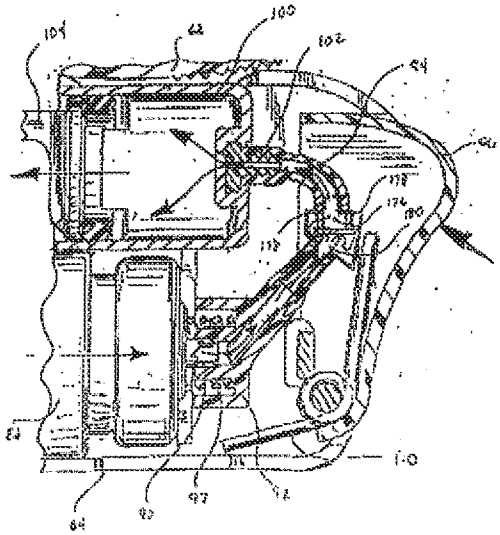




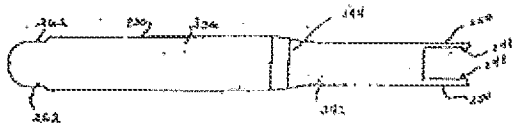
[Fig. 16]



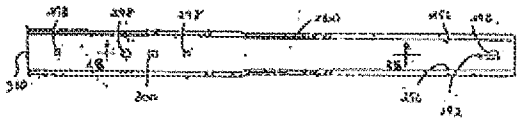
[Fig. 17]

[Fig. 22]

[Fig. 21]



[Fig. 27]



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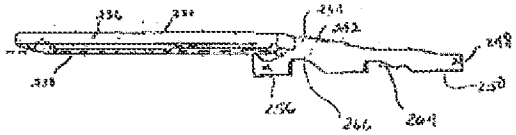
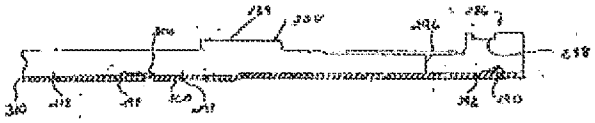
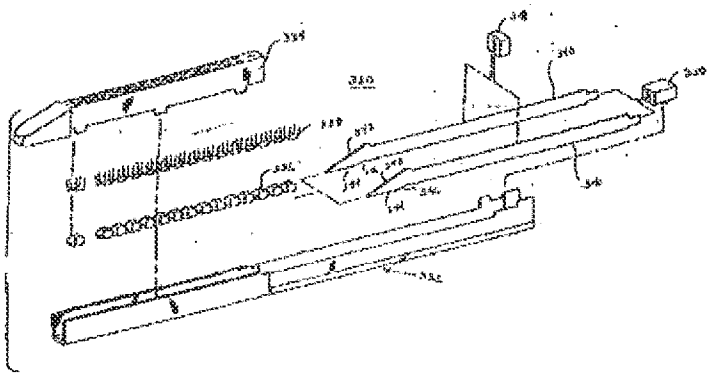
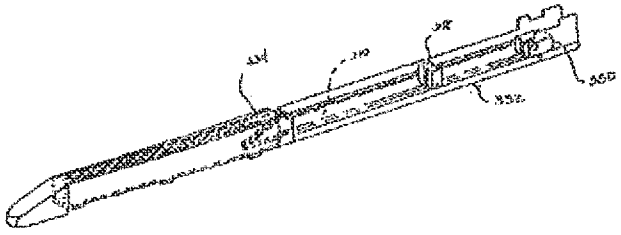




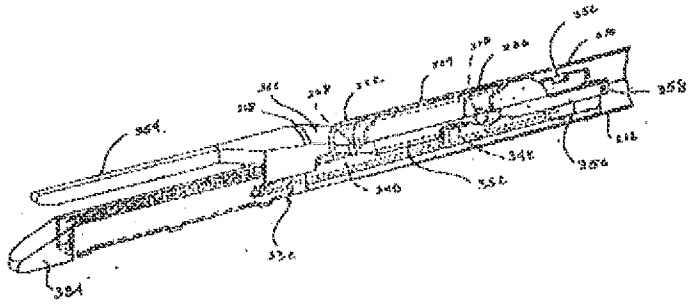
[Fig. 29]



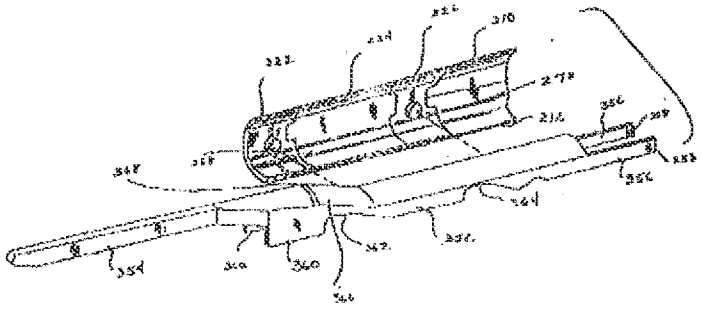
[Fig. 30]



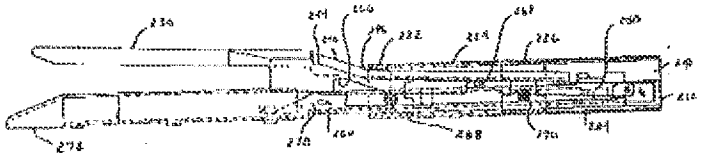
[Fig. 31]



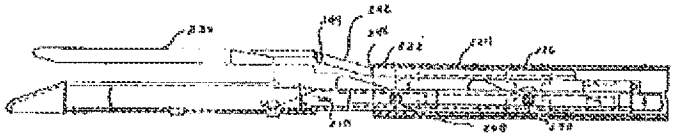
[Fig. 32]



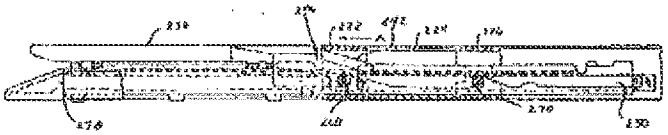
[Fig. 33]



[Fig. 34]



[Fig. 35]



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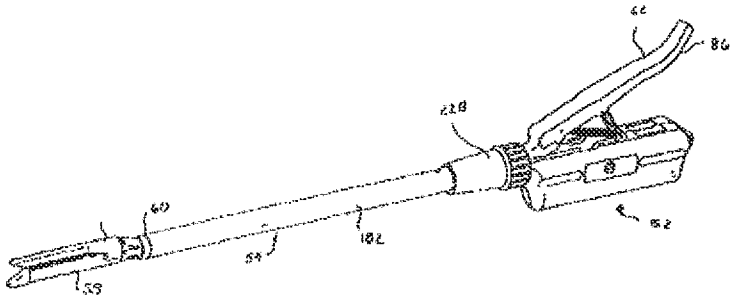
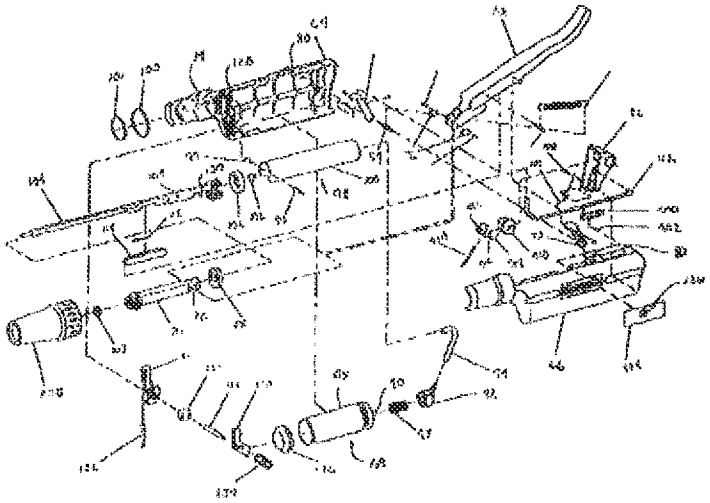
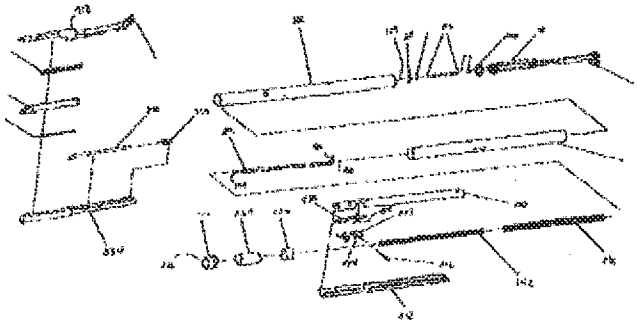


[Fig. 37]

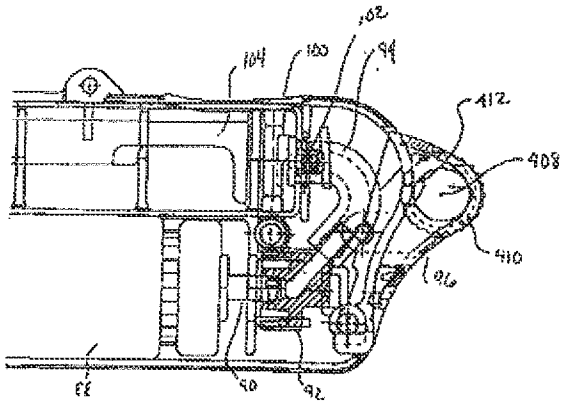


[Fig. 38]

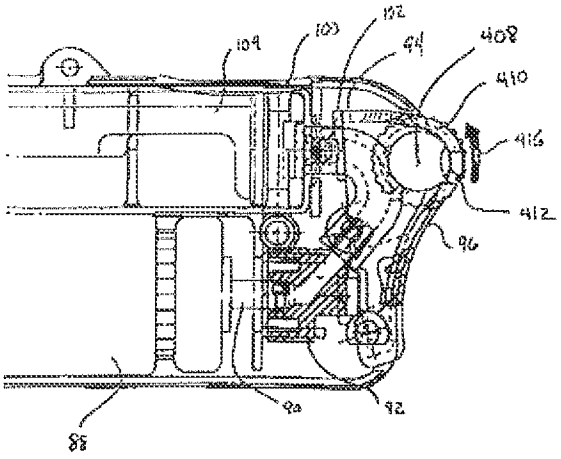


[Fig. 39]

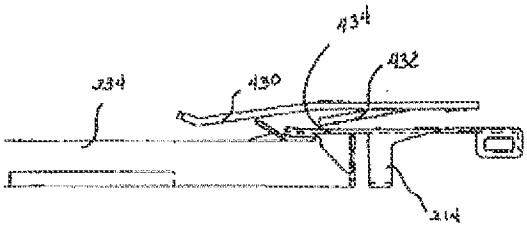
[Fig.40]

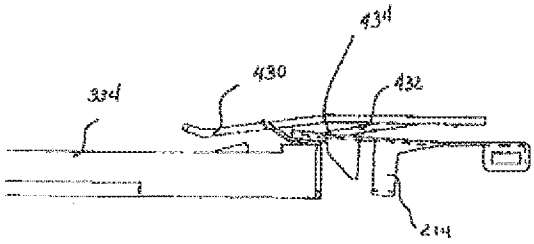



[Fig. 41]




[Fig. 42]



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